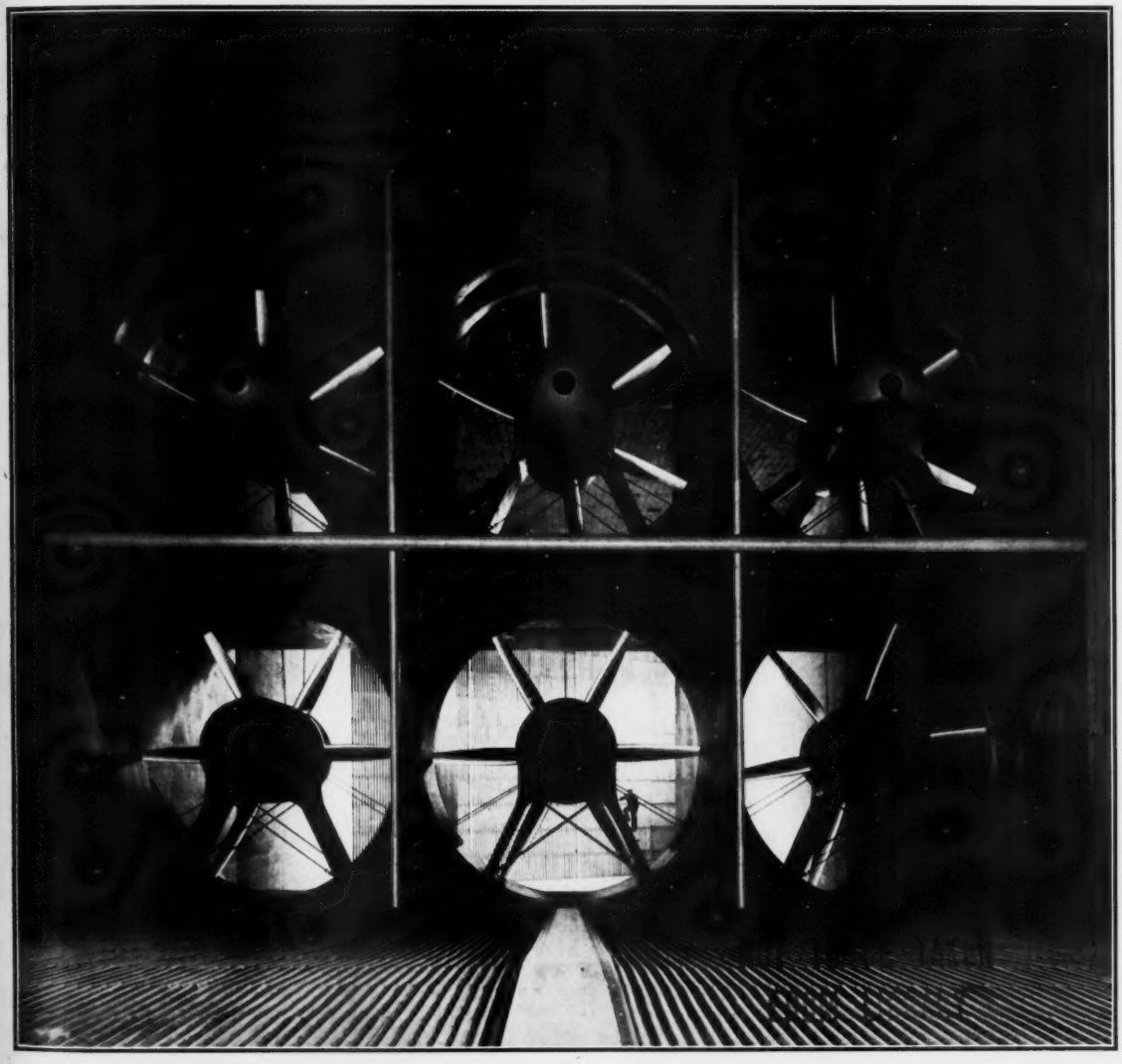
AERONAUTICAL ENGINEERING REVIEW

NOVEMBER 1944



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Air Power and the Engineer

(A Guest Editorial)

EUGENE E. WILSON*

United Aircraft Corporation

THE DECISIVE CHARACTER of Air Power in war is now apparent to all. Many are beginning to anticipate its character in peace.

History records two great periods of peace—the Pax Romana, and the Pax Britannica. We associate both these periods with force—the Pax Romana, with the Roman legions; the Pax Britannica, with the proud tradition of the Royal Navy: "Britannia rules the waves"; "The sun never sets on the Union Jack."

Today, we are conscious of the parallel between Sea Power and Air Power. We are coming to speak of Air Power not in the narrow connotation of Air Forces but in the broader aspect of the Air Forces plus Air Commerce plus Aircraft Manufacture, Air Bases, and Air-mindedness.

Mahan, the historian, in the classic, *The Influence of Sea Power Upon History*, proved conclusively that victory in war and prosperity in peace rest with him who controls the sea. To Mahan, the backbone of Sea Power was the merchant marine. The spectacular advance of Air Transport in this war offers promise that in the Air Age, Air Transport will be the heart of Air Power; Air Force, its sinews; and Aircraft Production, its backbone.

A future Mahan may record that victory in war and prosperity in peace rest with him who controls the air. Meanwhile, as we witness the rise of Air Power, aeronautical engineering is still in its pioneering phase.

Following the Civil War, Western pioneers, struggling against numerous physical handicaps, opened up and exploited the natural resources

of the West. Since the discovery of the Wright brothers, aviation pioneers, working likewise against great vicissitudes, have opened up new frontiers—the frontiers of tech nology. In fact, the aviation pioneers have created a completely new technology—still in its infancy.

It is clearly recognized now that advanced technology is the key to Air Power. The history of aviation is the record of accomplishment of the technologically impossible. But this accomplishment was the result of the struggle for survival by the aviation pioneers. Rapid technological progress can only result from competition in private industry.

The creative efforts of the pioneer aircraft manufacturers—men who were predominantly engineers—brought us to the outbreak of World War II with the superior technology. Thanks to these creative efforts, we had a new concept of flexibility in production. Our advanced technology and the ability to expand rapidly in emergency were strategic assets of vital importance. We must retain them.

Men always hope that the time may come when peace may prevail by agreement throughout the world. Men hopefully preach the doctrine of "one world." Cold experience shows that we are at least two worlds. It is the conviction of many of us in aviation that it is our responsibility to maintain the dominant Air Power to promote the peace and prosperity of the world.

Here, again, we note the parallel with the Pax Britannica that accompanied the British control of Sea Power. Then the world enjoyed unexampled prosperity coupled with spiritual and material progress never before experienced. Piracy was swept from the high seas. The right of innocent passage was guaranteed. The free play of natural competitive forces accelerated the advance of the arts and sciences. Peace and prosperity reigned because the Power was in the hands of free and beneficent people.

The United States has the dominant Air Power. To some of us it seems our American responsibility to maintain this power so that the period ahead may produce a Pax America. It might if we rise to our responsibility and utilize our dominant Air Power to keep the peace.

Since the key to dominant Air Power is technology and since we are but upon the threshold of important new technological developments, the opportunities for creative engineering in private industry are great. The close of the war obsoletes the weapons with which it is won, as the Superfortress bombs Tokio, that buzz bomb strafes London. The possibilities of this development are breathtaking!

Every engineer appreciates and values the affiliation with a professional society. Such a society is the Institute of the Aeronautical Sciences, which bids fair to continue to play an important part in the advance of American Air Power.

* Vice-Chairman.

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Daylight Training of Pilots for Night Flying

J. G. BEEBE-CENTER,* L. CARMICHAEL,* AND L. C. MEAD*

Tufts College

SUMMARY

This paper deals with the psychophysiological aspects of a technique for training pilots in night flying during the daytime. The technique consists of covering the windshield and windows of the plane with green acetate and having the pilot-trainee wear red goggles. Under these conditions, the pilot's vision beyond the cockpit is cut down by the combination of both filters so that it approximates vision at night; his vision of the instruments is through the red filter alone and little impeded. The instructor sees beyond the cockpit through the green filter alone with little impediment; he sees the instruments without interposition of any filter whatever.

The principal experimental findings are as follows:

1. Judged in terms of depth perception, efficiency of vision for white targets during the transition from daylight to night begins to decrease definitely at a level of brightness of 7.0 log microfoot-lamberts, is about halved at a level of 4.4 log microfoot-lamberts, and deteriorates more and more rapidly thereafter.

2. Judged in terms of depth perception, decrease of brightness resulting from use in daylight of a combination of red and green filters with an overall joint luminous transmission of 0.0000037 has, in general, the same effect on visual efficiency as a corresponding decrease of brightness during twilight. In bright sunlight efficiency is about halved.

3. The range of individual differences in vision through the combination of filters corresponds, in terms of visual acuity, to the effect of a difference in brightness of about one logarithmic unit.

4. Adaptation to the combination of filters used in sunlight is 90 per cent complete at the end of 20 min.

5. For daylight illumination, use of the green filter alone (instructor's vision) decreases visual acuity by an amount corresponding to a decrease of illumination of between 1.0 and 1.19 logarithmic units, approximately the decrement in illumination from bright sunlight to overcast weather.

INTRODUCTION

IN THE SPRING of 1942 Capt. (then Comdr.) Luis de Florez asked the Laboratory of Sensory Psychology and Physiology of Tufts College to investigate the use of red and green filters for the simulation of night flying conditions during the daytime. The Commonwealth Fund, through Mr. Barry Smith, kindly agreed to finance such an investigation. Work on this problem has been going on since that time at Tufts and still continues.

The technique for simulating night vision with red and green filters is fundamentally as follows: The windshield and all windows of the airplane cockpit are covered with green acetate. The pilot—but not the instructor—wears goggles with red lenses. The green and red are so chosen that, in daylight, vision through either filter alone is little impeded, but vision through both together is cut down to approximate nighttime. Thus, the instructor's vision through the windshield is daylight vision, except for a slight decrease in brightness and a green coloring, and his vision of the illuminated instruments is wholly unimpeded; the pilot's vision through the windshield is approximately night vision, but his vision of the illuminated instruments is impeded only by a slight decrease in brightness and a red coloring. Fig. 1 shows these various forms of vision quantitatively for specific samples of green and red.

The utility of such a technique is twofold: In the first place, it allows the use of daylight hours for training in night flying, and thus more than doubles the effective training time because daylight allows denser traffic. Second, it allows the pilot to learn night flying while the instructor is seeing under daylight conditions, and thus markedly increases the safety of such training.

The research done at Tufts College in connection with this technique falls into five main parts:

(1) The validity of the technique in the specific case of two commercially available filters selected by Captain de Florez—namely, Lumarith Green 0-4403 and Polaroid Red XR-12. The question here is to determine the extent to which the combination of these filters decreases visual performance, measured in terms of one of the principal visual functions, to the level of night vision.

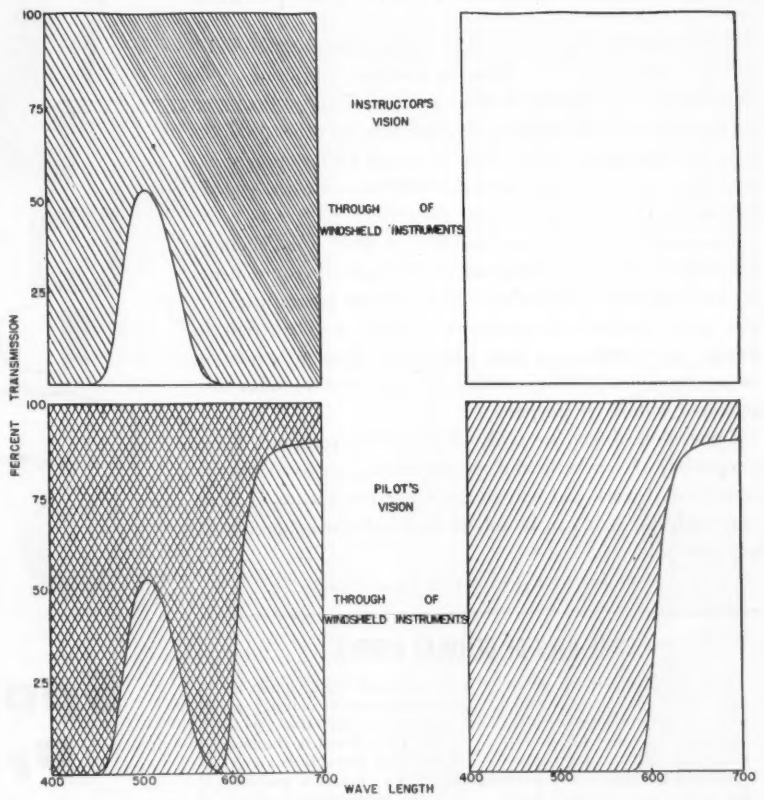
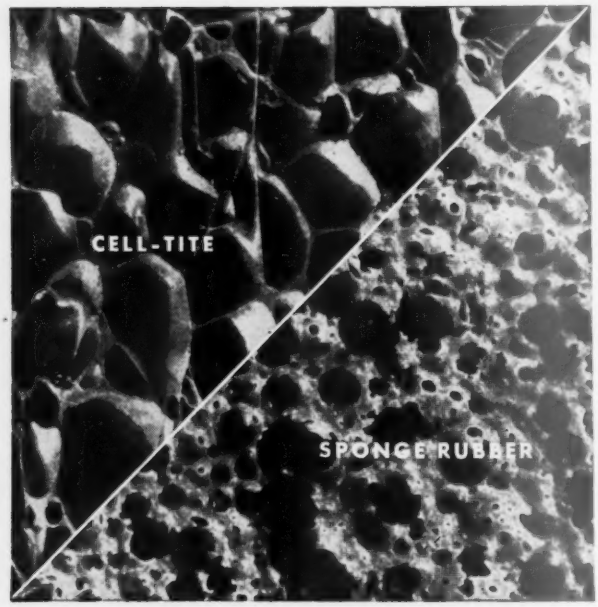


FIG. 1. Transmission of the green and red filters and their effect on the instructor's and pilot's vision.

Presented at the Air Transport Session, Twelfth Annual Meeting, I.A.S., New York, January 25–27, 1944.

* Research Associate, Director, and Assistant Director, respectively, Laboratory of Sensory Psychology and Physiology.



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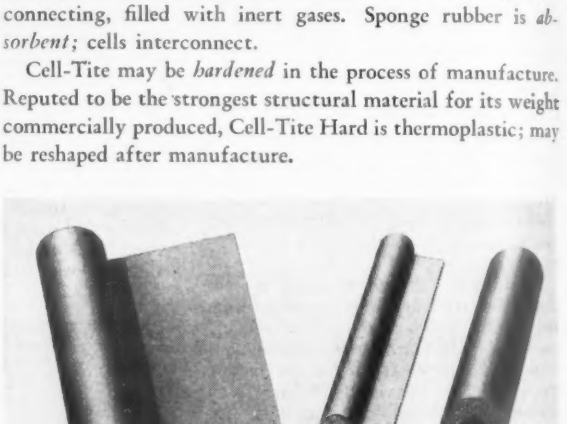

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(2) The problem of individual differences. The question here is the extent to which individuals vary in the degree to which their vision is affected by the combination of these two filters.

(3) The nature of the adaptation curve for vision through the red and green filters. Here the problem is to specify how long a pilot must wait after putting on red goggles in a cockpit fitted with green acetate before his vision has reached an approximate optimum for the new conditions.

(4) The problem of safety. The issue here is whether the instructor's vision through the green filter alone is adequate to insure safety of flight.

(5) Specifications for the green and red filters. The question here is to determine just what should be the characteristics of Lumarith Green 0-4403 and Polaroid Red XR-12 so that their combination will yield the best results.

The Problem of Validity

The Criterion

Night vision involves decreased efficiency in many functions: in sensitivity to contrast, in visual acuity, in perception of depth. Ideally, validation should involve all of these functions. Such complete validation, however, is never possible in actual practice. Considerations of time made it desirable to restrict the principal research to a single criterion, albeit several other criteria were dealt with in a secondary manner. The criterion chosen for intensive experimentation was relative depth perception, because this function was thought to be of cardinal importance in the landing of airplanes.

The Apparatus

There is always considerable risk in predicting from simplified miniature experiments to performance under complex field conditions. In consequence, it was decided that depth perception should be studied in a situation as realistic as possible, both in general nature and in scale.

The essential features of the apparatus used were a mock-up of a cockpit, located 35 ft. above the ground, and two white stimulus patches, one stationary and the other mobile. In one series of experiments the stationary patch was 100 ft. from the cockpit; in another it was at 200 ft. The observer occupying the cockpit was to set the mobile stimulus at the same distance as the stationary stimulus.

For the experiments at 100 ft., the dimensions of the patches were $15^3/_4$ by $13^1/_2$ in. and subtended a visual angle of approximately 45 by 39 min. Patches of the same angular size were used for observations at 200 ft.; their linear dimensions were $31^1/_2$ by 27 in. The angular separation of the centers of the stimulus patches at both observation distances was approximately $3^1/_2$ degrees.

Each patch was mounted on a cart and the carts were placed on slanted runways, the upper ends of which pointed toward the observer. The stationary patch was placed in the middle of one runway and the other moved toward or away from the observer along the other runway. The subject had no cues as to the relative distance of the patches from their apparent separation or from their height in the visual field in relation to other objects.

All parts of the apparatus except the test objects were painted flat black. The runways for the 200-ft. distance were 80 ft. long; those for the 100-ft. distance were 48 ft. long. Distances were indicated by figures at 10-cm. intervals along the sides, with zero at the center. Measurements on the observer's side of zero were arbitrarily called minus distances; those on the opposite side were called plus distances.

The cart bearing the movable stimulus (see Fig. 2) was moved by a rope that ran over a pulley at the top of the end upright and down to a windlass. Turning the windlass did not give a cue to motion because it was obscured by an equipment hut.

The cockpit was mounted on a tower built on the roof of the Tufts College Field House, the top of the tower being $31^1/_2$ ft. above the ground. This cockpit was approximately 6 ft. long, $2^1/_2$ ft. wide, and 5 ft. high, and contained two seats, one behind the other. The observer's head was thus about 35 ft. above the ground. Outside vision was permitted through window glass covered with green acetate at the front and along one side. In the cockpit, below the front window, was a Kollsman Instructional Aircraft Instrument Panel. The various dials and numbers on this panel served as a check for visibility inside the cockpit.

Experimental Procedure

The same experimental procedure was always used regardless of other conditions. One stimulus patch was placed at zero on a runway and the other was alternately placed at the top or bottom of the other runway. In an "ascending" run, one experimenter turned the windlass so that the moving patch came up toward the observer. By means of a microphone and amplifier in the cockpit and a loud-speaker below in the equipment hut, the subject verbally directed the placement of the moving stimulus. In the ascending run he was instructed to say "stop" when this stimulus appeared to him to be as near as the stationary stimulus. In a "descending" run he would stop the moving patch when it seemed as far away as the stationary stimulus. He was allowed further minor adjustments if he desired. Thus, after his first "stop," he might say "up a little," "now down a little," "up a bit more," "now read it." At this point the second experimenter would record the deviation (plus or minus) of the movable stimulus from zero. For a single threshold of depth discrimination 20 runs were made, ten ascending and ten descending. Care was taken to vary the speed of rotation of the windlass from one run to another. Essentially, this was the well-known psychophysical method of Average Error. Specially prepared data sheets facilitated the recording.

Two scores were obtained from any group of 20 measures. The average of the group, taken with respect to algebraic sign, gave the Constant Error, i.e., the average position (front or back) of the movable stimulus that is estimated by the subject to be equidistant to the stationary stimulus. The square root of the mean of the squared deviations from the mean gave the Standard Deviation (sigma), which provided a measure of the variability or scatter of the settings around the Constant Error.

The experiments to be described could not have been performed without two additional pieces of equipment, a Macbeth Illuminometer and a Taylor Low-Brightness Meter (Model A). By using the necessary filters with the Macbeth instrument, it was possible to measure outdoor illuminations between 0.15 and 10,000 foot-lamberts. The Taylor instrument was utilized during twilight and at night, and allowed the measurement of illuminations ranging between 0.15 and 0.000001 foot-lamberts.

Brightness was always measured on one of the white stimulus patches placed at a constant position on its runway. The reflection coefficient of this patch was approximately 85 per cent, and the light meters were held normally to its surface. The measurements were always of brightness, i.e., of the amount of light diffusely reflected. Thus, if 100 foot-candles were falling on the surface, the measurement would be of 85 foot-lamberts (apparent foot-candles). Brightnesses above 0.15 foot-lamberts were measured with the Macbeth Illuminometer; those below this level with the Taylor Low-Brightness Meter

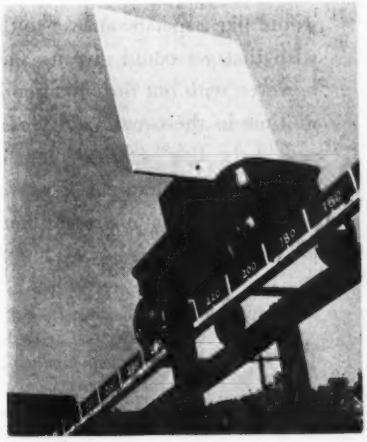

Fig. 2. Test stimulus mounted on runway of depth-discrimination apparatus.

The American public, the aviation industry in general and a number of aircraft manufacturers in particular would like a specific answer to this question . . . and we wish that we could give it. This much can be said, however, with but little likelihood of disagreement. At no time in the twenty-odd years since the world witnessed the first practical flight of a rotary wing ship, has professional and public interest in rotary wing flight been as active as at present, *nor has the future of the field been as promising* ★ The Autogiro Company of America has been engaged in rotary wing research and development longer than any other organization in America. Its engineering and research staff; its records of development, experimentation and thousands of hours of flight, and the right to use its numerous inventions, offer incalculable assistance to licensees. We shall be pleased to discuss details of Autogiro Company licensing arrangements with interested aircraft or other manufacturing executives ★ AUTOGIRO COMPANY OF AMERICA, Willow Grove, Pennsylvania.

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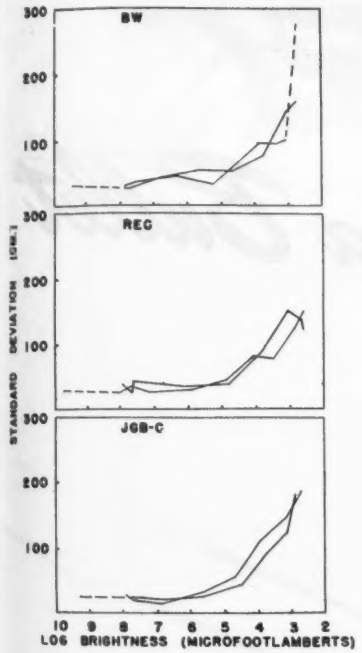


FIGS. 3, 4, and 5. Standard deviation of depth discriminations at 100-ft. distance as a function of outdoor brightness for three observers.

RESULTS

General Procedure

In the case of the 100-ft. distance, depth perception was studied for six observers under each of the three following conditions: (a) depth judgments in full daylight without filters. (b) Depth judgments in full daylight through the combination of red and green filters. (c) Depth judgments as darkness fell without filters (real night).

Data were also secured from one observer under condition (b) alone.

For all of these conditions, the brightness of the test patch was measured for each set of 20 judgments constituting an experimental series. Thus all of the data can be presented in terms of a common independent variable, brightness. Because of the large range of brightness involved (from about 6,000 foot-lamberts for full sunlight to about 0.0002 foot-lamberts for a moonless night with sky glow) and because of the general operation of the law of diminishing returns (called Weber's law in psychology) brightness is specified throughout in terms of logarithms of microfoot-lamberts (log μ foot-lamberts).

Choice of Measure

It was pointed out above that two measures of depth perception were calculated for each series of 20 judgments: a measure of consistency, the Standard Deviation (square root of the mean of the squared deviations from the mean of the 20 settings of the variable), and a measure of accuracy, the Constant Error (the algebraic mean deviation of the 20 settings of the variable from the standard). Is one of the measures more serviceable than the other in connection with the present problem?

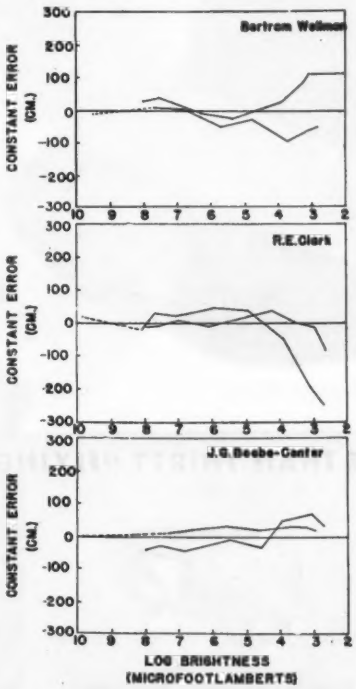
Figs. 3, 4, and 5 show the relation between the S.D. (Standard Deviation) of series of 20 judgments and the brightness for three observers viewing the test plates without filters during daylight and dusk. The figures show two sets of data for each observer. It is obvious that the S.D. increases with decrease of brightness according to a curve that is much the same for both sets of data for all three observers.

Figs. 6, 7, and 8 show, for the same original data, the relation between the C.E. (Constant Error) and brightness. It is obvious that the relation is different for different observers and even for the two series of observations of a single observer.

It is not the place here to argue the merits of the S.D. and the C.E. in general. There is no question, however, but that for the particular problem at issue the C.E. is of little value because no general statements can be made about it. In consequence, results will be presented in terms of S.D. It might be added that where, as here in the case of low brightnesses, the S.D. is large, this statistic represents not only low consistency of judgments but large inaccuracy of some of these judgments and that it thus constitutes, again for the problem at issue, a measure of general efficiency.

Depth Judgments at Night Without Filters

Fig. 9 shows, for all seven observers and for depth judgments without filters



FIGS. 6, 7, and 8. Constant error of depth discriminations at 100-ft. distance as a function of outdoor brightness for three observers.

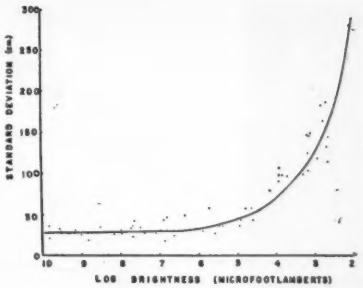


FIG. 9. Standard deviation of depth discriminations at 100-ft. distance as a function of outdoor brightness for seven observers.

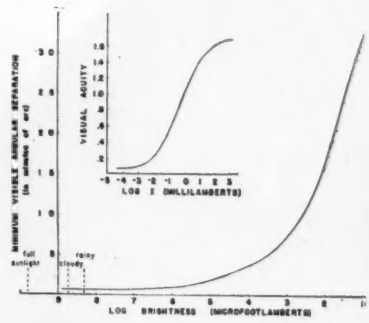


FIG. 10. Visual acuity and minimum visible angular separation as a function of brightness.

both during daylight and dusk, the relation between the S.D. of series of 20 judgments and the brightness. Dots represent values for sets of 20 judgments. The curve is one of best fit by mere inspection. The clustering of the dots around the curve leads to the conclusion that the curve is a good expression of the relation of consistency of relative depth perception to brightness.

That this curve is not only a good expression of this latter relationship but also of the much more general relation of perceptual efficiency to brightness is suggested by consideration of the relation of visual acuity to brightness. The classical data here are those of König,[1] who measured for different amounts of illumination the visual angle which must separate two contours in order that they may be recognized as discrete. The usual way in which these data are presented is to plot the logarithm of the illumination against the reciprocal of the visual angle of the just noticeably discrete contours. This form of plotting yields the S-shaped function shown as an inset in Fig. 10. Although this function is useful for the theory of vision, it does not show at a glance how much the visual angle has to be increased as illumination decreases. In order to bring out this latter relationship, Fig. 10 shows for the same data the minimum visible angular separation against illumination in log μ foot-lamberts. Use of these units permits an easy comparison of the acuity data with data on depth perception (see

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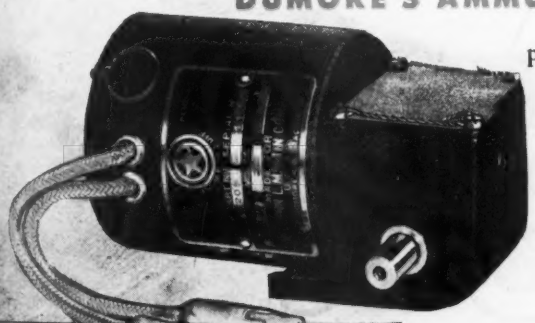
After victory, the machine guns served by this motor will probably be retired but the motor itself, and the design features marking it and thirty-odd other current Dumore Motors will be advantageously applied to countless peacetime drive duties.

DUMORE'S AMMUNITION BOOSTER MOTOR A1B1PL



packs a powerful 1/6th h. p. into a 2 pound, 14 ounce drive unit less than 6 inches long. It includes worm gear reduction and overrunning clutch and is conditioned for high altitude operation and protected against corrosion. This motor is fully described in the Dumore Aeromotor Catalog. Write for your copy today! The Dumore Company, Motor Division, Dept. ML10, Racine, Wisconsin.

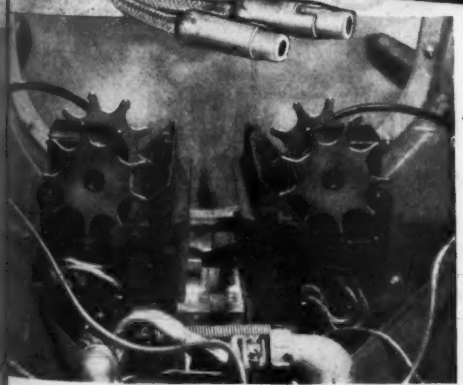


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Fig. 9). This comparison suggests that depth perception and visual acuity become impaired in similar fashion as illumination is decreased.

Comparison with Depth Judgments in Daylight with Filters

With respect to the problem at issue, that of the validation of the use of the red and green filters for the simulation of night vision, the results presented above establish a definite standard of comparison. The next step is obviously to ascertain to what extent depth judgments in daylight through the red and green filters reproduce depth judgments at night. The joint transmission of the red and green filters, measured by a method we shall discuss later, was found to be 0.00000377. Knowing the brightness of the test patch for a series of 20 judgments through the two filters, it was possible to calculate by simple multiplication the brightness of the test patch as seen through the two filters. Thus, it was possible to plot the relation between S.D. of judgments and effective brightness in the same coordinate system as that used to represent the data secured without filters. In Fig. 11 the dots represent the relation to effective brightness of depth judgments while looking through the red and green filters in daylight; the curve is a segment of that shown in Fig. 9 and represents the relation of depth perception without filters to the brightness of the test patch.

For brightnesses around log 4.5 μ foot-lamberts (this corresponds to use of the red-green filters in strong sunlight) the increase of variability for judgments with filters is about the same as for an equivalent change of brightness at twilight. For lower brightnesses the data are too few to warrant a definite conclusion. They suggest, however, that variability increases more rapidly with the filters than it does for comparable changes of brightness at twilight. At any rate, visual depth discrimination, when the pilot wears the red goggles and looks through the green windshield, is impaired at least to the degree found after dark. We may conclude that this form of simulated night is at least as detrimental to visual depth discrimination as real night, if not more so.

Results at 200-Ft. Distance

The procedure, in the case of depth perception at 200 ft., was the same as for depth perception at 100 ft.

Fig. 12 is a plot of the consistency (Standard Deviation) of depth settings for four observers. Points connected by solid lines are for data obtained as darkness came on. The points at the left, connected to the solid lines by broken lines, represent measurements in full sunlight. The X's show the effect of the red-green filter combination on depth judgments in full daylight. Again, for brightness around 4.5 log μ foot-lamberts, variability is increased to about the same amount whether the brightness is due to cutting down sunlight by means of the filters or simply to the effect of twilight.

If one compares the curves of Fig. 12 to the standard depth discrimination curve as a function of illumination already presented as Fig. 9, one finds a striking similarity. A best-fitting curve (by visual inspection) of Fig. 12 would closely parallel that of Fig. 9, the standard deviation of the former, however, always being greater. Variability of judgments for both the 100- and 200-ft. distances remains constant for brightnesses above 7 log μ foot-lamberts. A definite increment in variability occurs when the illumination gets below 6 log μ foot-lamberts, and a steep gradient is found below 3 and 2 log μ foot-lamberts. These latter brightnesses are somewhat below the limits of ordinary retinal cone vision.

Although consistency, as measured by the Standard Deviation in centimeters, is greater at 100 than at 200 ft., this relationship does not hold when the Standard Deviations are expressed in "stereopsis angles."* In fact, the stereopsis angle is consistently less at 200 ft. Fig. 13 shows this plot for the standard curves at 100 and 200 ft. From these we may conclude that stereopsis angle becomes less with an increase in distance although the linear depth separation of these objects becomes greater. Reduction of illumination, however, produces a comparable decrement at both distances.

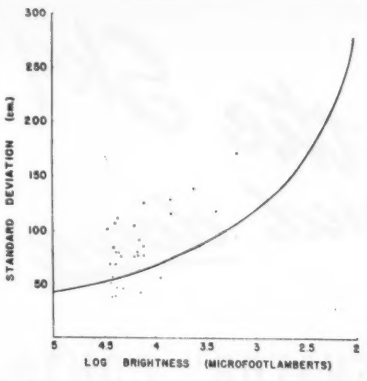

FIG. 11. Standard deviation of depth discrimination as a function of brightness with red and green filters (dots) and with normal vision (curve).

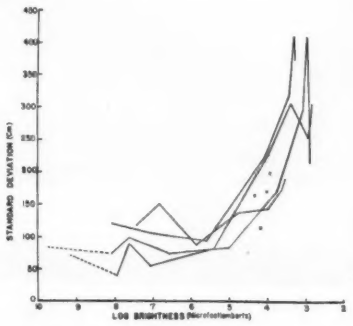

FIG. 12. Standard deviation of depth discriminations at 200-ft. distance as a function of outdoor brightness for four observers. Crosses represent daytime vision through red and green filters.

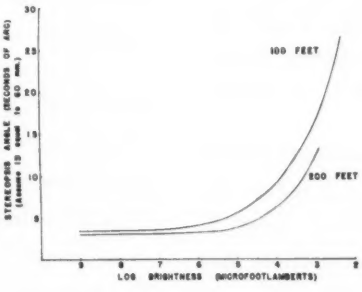

FIG. 13. Stereopsis angle (based on standard deviations) as a function of outdoor brightness for 100- and 200-ft. distances.

CHANGE OF ILLUMINATION FROM NOON TO NIGHTFALL

Validity, in the present context, means practical validity. The problem is not merely whether night vision can be produced synthetically for one specific condition of illumination, but whether it can be produced for a considerable part of the working day. The solution of this problem depends in turn on the degree to which illumination remains approximately constant at different times of day and under different atmospheric conditions.

Information on this question is available as a by-product of the investigations described above. In their course, the brightness of the test patch was recorded at various frequent intervals (from 1 hour to 3 min.) throughout the day and twilight on different dates during 1942 and 1943. The observations were made under many different atmospheric conditions, from clear, cloudless days to rainy days. The effects of different phases of the moon were also studied. When observing the brightness changes between twilight and darkness, measurements were made every few minutes until the night illumination became constant. This constant level, owing to sky glow, was unavoidably higher than it should have been. The same observer (L. C. Mead) took all the readings and took care to become dark-adapted as much as the open space environment would permit.

Fig. 14 presents a smoothed family of curves for cloudless days and evenings during different seasons of the year

* Stereopsis angle refers to the angular difference in seconds of arc between the angles subtended by the eyes at two objects just noticeably different in depth. It is computed by the formula:

$$\text{Stereopsis Angle} = (AN/M^2)\ (206{,}000)$$

where A = interpupillary distance; N = distance separating two objects just noticeably different in depth; M = distance; and 206,000 = conversion to seconds of arc.

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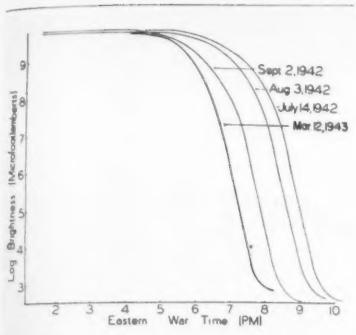


FIG. 14. Brightness of stimulus patch in constant position as a function of time of day at different seasons of the year.

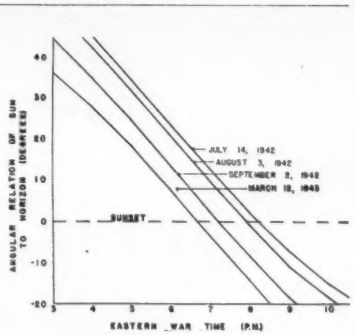


FIG. 15. Angular height of sun as a function of time of day at different seasons of the year.

which shows the relationship between the brightness of the test patch and time of day. The time of sunset for these days is known and indicates that brightness remains remarkably constant from noon to within 2 hours of sunset. A rapid drop occurs during the next 3 hours. During the steep part of the curves the brightness drops at such a rapid rate that at the end of a 5-min. period it is approximately half of what it was at the beginning of the period. Typical illumination changes from the period of constancy at day to constancy at night are from 6,500 to 0.0007 foot-lamberts, a more than millionfold shift. In logarithmic units and microfoot-lamberts this shift is from 9.80 to 2.85 log μ foot-lamberts.

Outdoor Illumination

On overcast days (no sun visible but not raining) the daytime brightness is approximately one logarithmic unit less than on a clear day. The curve starts to drop earlier but joins the "clear-day curve" at about sunset. Even on rainy days the illumination is higher than casual impression would suspect. The lowest brightness obtained on such days was 8.16 log μ foot-lamberts.[2] There seems to be no uniformity to the density of atmospheric clouds and haze. About the only conclusion that can be drawn is that, when such atmospheric conditions exist, the outdoor illumination is between one and two logarithmic units less than on a clear day during daylight hours. Dense haze, such as would almost eliminate shadows, is not particularly effective in cutting down the illumination, the drop usually being less than one logarithmic unit.

Since the stimulus brightness at a given time of day will depend on the season of the year as well as latitude, it is desirable to relate brightness to a more stable variable than time. An obvious relationship that might hold, regardless of time of year, is the relation of brightness to angular elevation of the sun above the horizon.* In consequence, the angular elevation of the sun at different times of day was calculated for the dates shown in Fig. 14.† Fig. 15 shows the resulting relationship. Since the time axis is the same in both Figs. 14 and 15, it is possible to construct a new graph showing the brightness, on any day, in relation to the angular elevation of the sun. This process essentially amounts to the elimination of time of sunset as a variable. If brightness is directly related to angular elevation of sun, then the plotted points of this relationship should all fall on the same curve regardless of season of the year. Fig. 16 shows a smoothed curve of this plot with the data for different days appropriately indicated. These data certainly approximate the same curve.

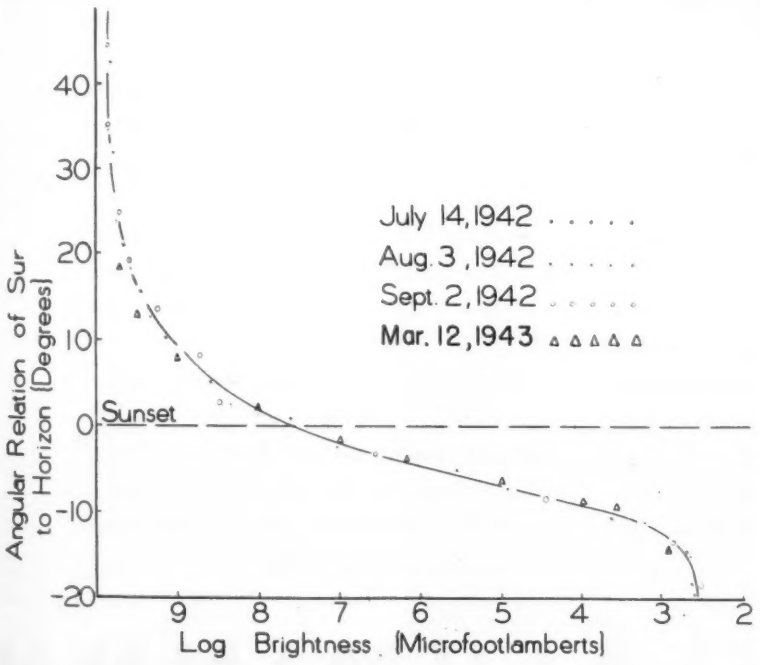


FIG. 16. Brightness of stimulus patch in constant position as a function of angular height of sun at different seasons of the year.

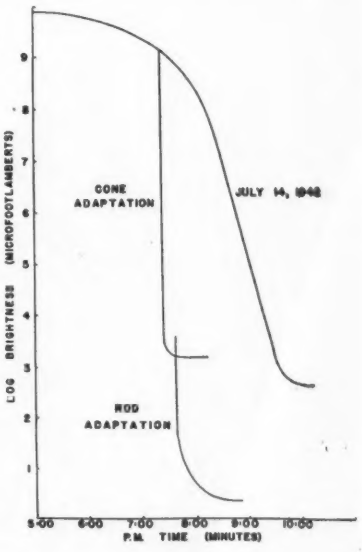


FIG. 17. Dark adaptation of the human eye compared to the decrease in outdoor brightness during twilight.

For our latitude (42.5°), then, we conclude that the light reflected from a stimulus patch not in the shadow of the sun can be calculated from the angular elevation of the sun. This finding appears to hold for all seasons of the year.

---

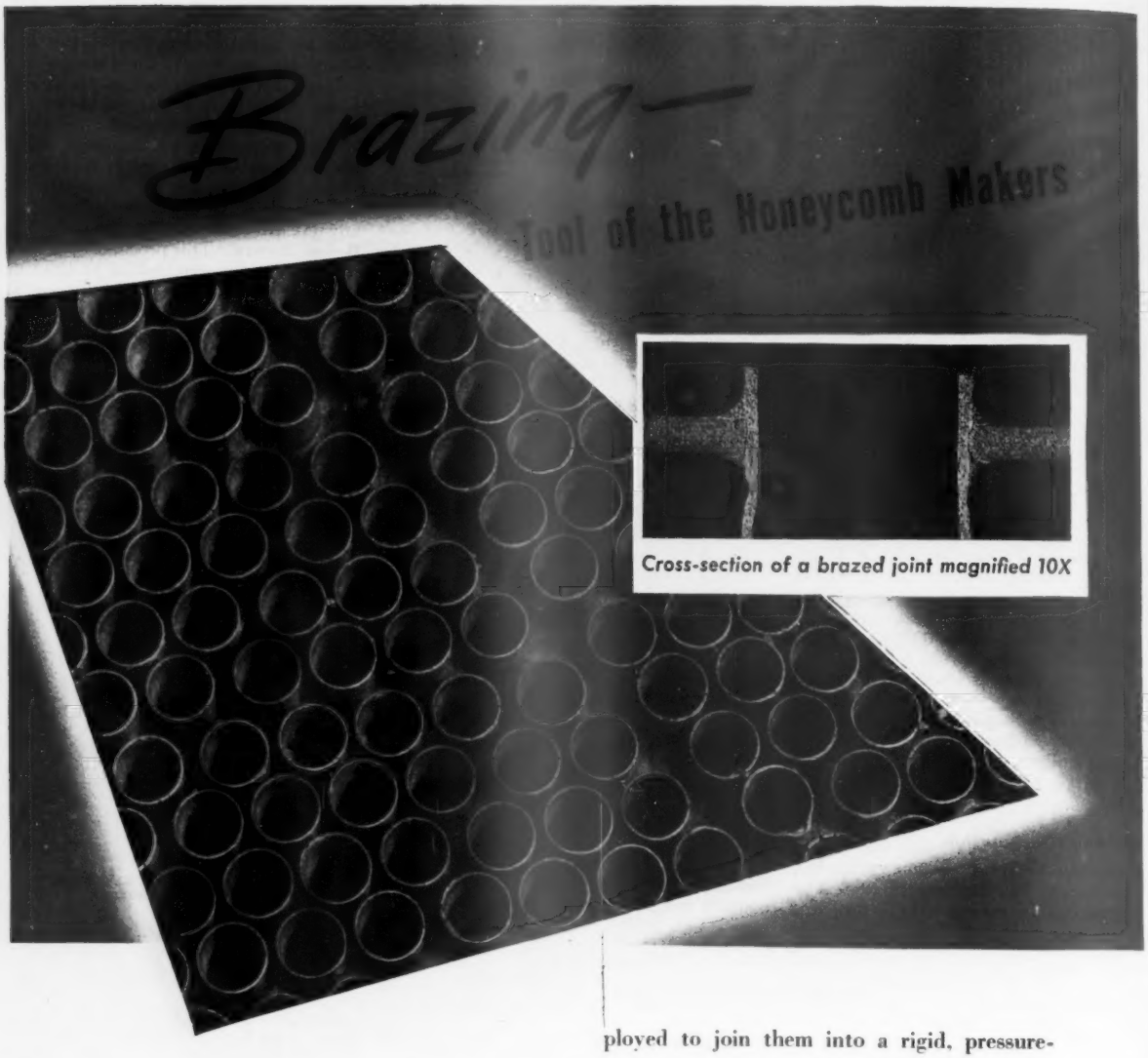
* The normality of the sun and moon does not appear to affect the illumination as much as it should according to the cosine law of reflection, probably because of diffusion by the atmosphere.

† Computation of angle of the sun for time of day was done with the following formula, provided by the Department of Astronomy of Tufts College:

$$\cos p = \sin L \sin z - \cos L \cos z \cos T$$

where p = angular distance from zenith
L = latitude
z = declination
T = time

Angle of sun above horizon equals $90° - p$.



Cross-section of a brazed joint magnified 10X

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Twilight and Adaptation

The steepness of the curve of decrease of outdoor brightness during twilight raises a question of importance to night flying though not to the reproduction of night conditions by means of red and green filters: Does the eye adapt fast enough to keep up with the fall of environmental illumination?

In order to answer this question, one of the standard curves of dark adaptation[3] was compared to the brightness curve for July 14, 1942. A point was found on the latter curve that represented the same brightness as the beginning of the dark adaptation curve. Fig. 17 presents this comparison in graphic form.

The outstanding fact about Fig. 17 is that, for the whole range of brightnesses from daylight to darkness on July 14, 1942, the rate of dark adaptation is more rapid than the rate of darkening. It should be remembered, however, that the eye is usually in complete darkness between trials when a curve of dark adaptation is being determined. Since this is not the case outdoors during twilight, it may be that the rate of adaptation is somewhat slower than shown in Fig. 20.[4] Nevertheless, it seems reasonable to conclude that the retina will adapt quickly enough to compensate for the lowered illumination created by the setting sun at this latitude.

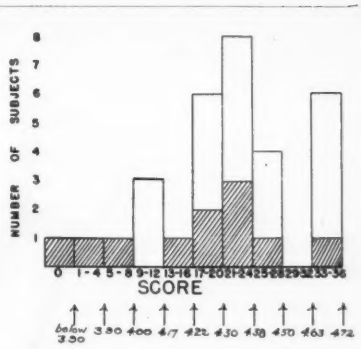


Fig. 20. Distribution of visual-acuity test scores for 32 observers wearing red-green goggles.

Individual Differences

Before a technique for daylight reproduction of night vision can be put into use it is necessary to know how differently various individuals react to the technique. For this reason it was decided to investigate individual differences in vision through the combination of green and red filters.

The effect of the filter combination on an individual was measured by means of a test of visual acuity. The test stimuli were nine rows of four white E's presented on a black background at a distance of 40 ft. from the observer, each E being in one of four positions. The sizes of the E's are specified in Table 1 in terms of the thickness of the lines constituting the E's (dimension 1 of Fig. 18). The E's in any one row were of the same size but their size decreased from the upper row downward. (See Fig. 19.)

Table 1

Row	Inches	Minutes of Arc Subtended at 40 Ft.
1	0.65	4.6
2	0.57	4.0
3	0.50	3.5
4	0.45	3.2
5	0.42	3.0
6	0.38	2.7
7	0.35	2.5
8	0.30	2.3
9	0.25	1.9

The observer was required to state the orientation (open end up, right, down, or left) of each E. His score was the total number of E's whose orientation he had correctly specified. Thus, score on this test varied from 0 to 36.

An earlier investigation had shown that there were no significant differences in depth perception when the two filters were mounted together in a goggle instead of having the red filter mounted in a goggle and the green filter mounted on the glass surface of a cockpit. For the sake of simplicity the former procedure —that of mounting both filters in the goggle—was used in the present experiment.

The transmission of an area in the left part of the goggle was found to be 0.0000053, that of a corresponding area in the right part 0.0000034. The brightness of the white cardboard under the test conditions was about 5,100 foot-lamberts. Thus, the apparent brightness of the stimuli to the observer was:

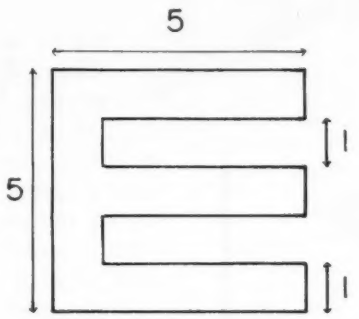


Fig. 18. Proportional dimensions of test stimuli used in study of visual acuity.

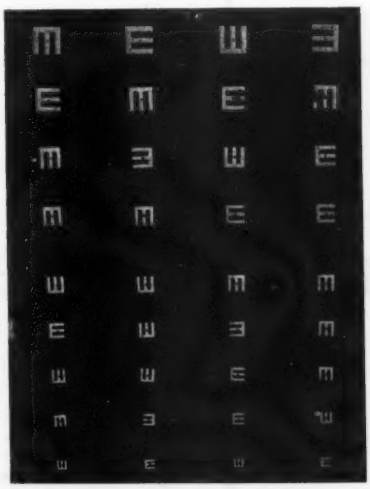


Fig. 19. Test board and stimuli used in study of individual differences in visual acuity while wearing red-green goggles.

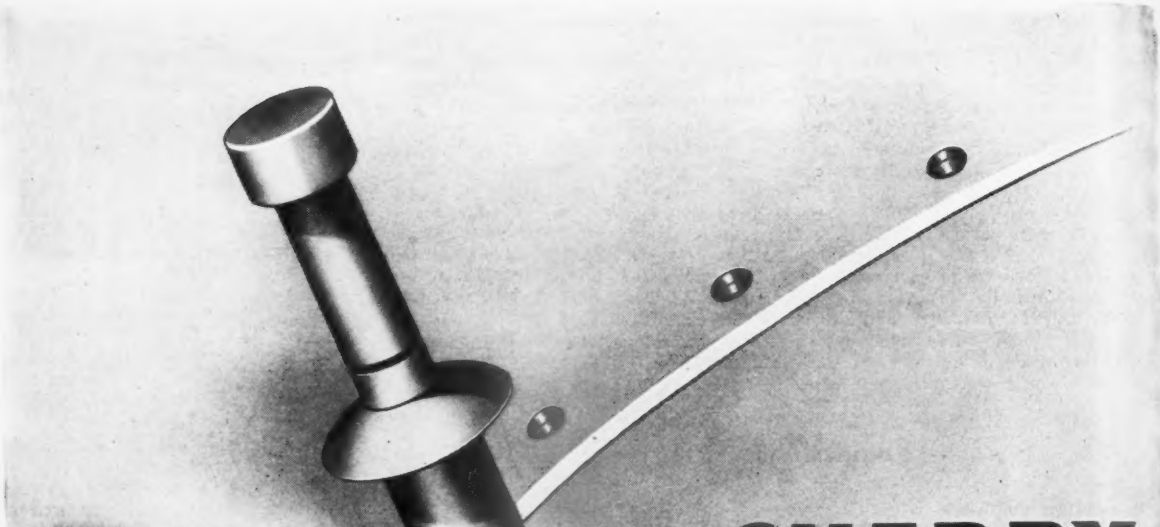
for vision through the area measured in the left part of the goggle, 5,100 × 0.0000053 = 4.43 log μ foot-lamberts; for vision through the area measured in the right part, 5,100 × 0.0000034 = 4.23 log μ foot-lamberts. König's data on visual acuity (from Hecht[1]) give, for such brightnesses, visual acuities of 0.36 and 0.28, respectively, corresponding to visual angles of 2.8 and 3.6 minutes of arc. Thus, for the brightness level used in this test, the stimuli of rows 6 and 3 represent, respectively, the acuity to be expected from König's data (presumably for an "average" observer) for vision through the left and right parts of the goggle.

Reliability of the Test

The first task was to determine the reliability of the test—the degree to which an observer's score on one occasion will be reproduced on another occasion. For this purpose, 22 observers were selected at random and tested twice, each time after a period of 20 min. of adaptation with the goggles. The coefficient of correlation between the two sets of scores (test-retest reliability coefficient) was 0.83. For this number of cases a coefficient of 0.54 would be secured by chance in but one instance in a hundred.[5]

The next task was to determine the extent to which pilot candidates may be expected to vary in their ability to see through the combination of filters. For this purpose use was made of the results on the first test of the 22 observers mentioned above, as well as of the results from ten observers subjected to but a single test after wearing the goggles for 20 min. Fig. 20 shows, for each of ten class intervals, the number of individuals whose scores fall within that class. In the case of each column in the figure the number of individuals who were wearing glasses is indicated by the shaded part of the column.

How should this distribution of scores be interpreted? A score of 4 means essentially that the observer can discriminate symbols whose lines subtend 4.6 min. Such discrimination is represented by a visual acuity of $^1/_{4.6}$ = 0.22. According to König's acuity data, this acuity is normally obtained with an illumination of 3.90 log μ foot-lamberts. Scores of 8, 12, 16, 20, 24, 28, 32, and



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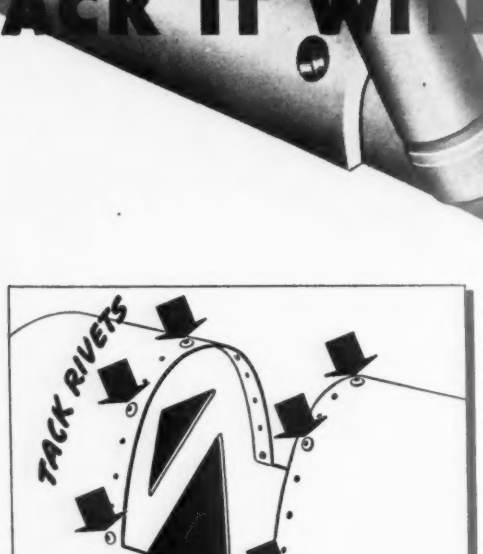

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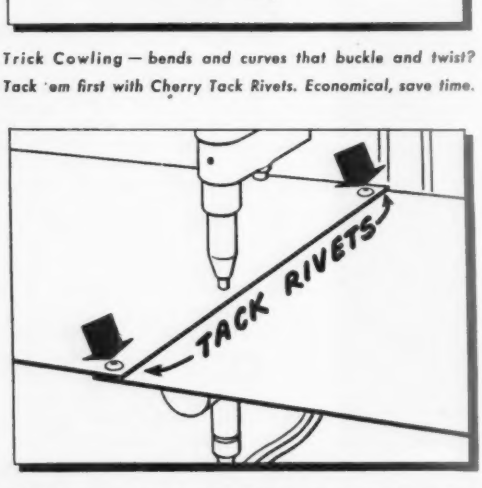

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36 similarly represent visual acuities normally obtained with illuminations of 4.00, 4.17, 4.22, 4.30, 4.38, 4.50, 4.61, and 4.72 log μ foot-lamberts. These levels of illumination are indicated in Fig. 20 for the various boundaries between classes of scores. The figure shows, therefore, for any score except zero, which is indefinite, the approximate level of illumination that should yield that score for a normal observer, according to König's data. Thus, an individual whose score on the test is 4 may be considered to see through the two filters as though the illumination were 3.90 log μ foot-lamberts, a degree of darkness that is not far above the rod threshold. An individual whose score is 36, on the other hand, may be considered to see as though in an illumination of 4.72 log μ foot-lamberts, an illumination corresponding to extremely bright full moonlight.*

* Taylor[6] gives as 0.0030 foot-lamberts the brightness of grass in full moonlight. We have found that the brightness of the white surface used in measuring illumination in our experiments is about ten times greater than that of grass. Thus the data of Taylor indicate that full moonlight would correspond to a level of illumination as measured in our experiment of 4.47 log μ foot-lamberts.

Optimal Adaptation Time

When making the transition from daylight vision to vision through the red and green filters, an observer at first sees practically nothing. Only after dark adaptation does he achieve the degree of visibility associated with night vision. The question immediately arises: How long must he dark-adapt in order to approximate optimal visibility for the particular brightness involved?

Since it is well known that visual acuity (the ability to discriminate between contours) varies systematically with illumination, dark adaptation can be measured by using a test of visual acuity and noting the times at which the observer is able to complete the various steps of the test. Such a procedure was followed with four observers using a test similar to the one described in the preceding section but involving ten sizes of E's and covering a considerably wider size range (0.25 to 3.75 in.).

Test Procedure

The test procedure required the observer to name the correct orientation of all four stimuli in a row (probability of so doing by chance is $^1/_{256}$) before he was given credit for discriminating that row. The time of correct response was recorded for each stimulus size. Data were collected only on clear days. The brightness variation of a white cardboard patch mounted on the test board was between 4,476 and 6,851 foot-lamberts. Logarithmically, this amounts to a variation of less than one-quarter of a log unit (9.65 − 9.84 log μ foot-lamberts).

Fig. 21 shows a plot of the curve of dark adaptation for four practiced observers. The curves are practically identical for the first minute, and similar after the first 5 min. Differences between these time limits are in part due to unavoidable errors in recording and speed of verbal response of the subjects, since the speed of adaptation is so great during this period. Most of the adaptation appears to be over in 15 or 20 min.

Table 2, made from the curves shown in Fig. 21, seeks to answer the specific question presented in the first paragraph of this section. Considering the smallest size correctly discriminated in an hour period of adaptation as the maximum acuity of the observer, this value was divided by the size just discriminated at various time intervals during the 60 min. and the result multipli d by 100. These percentages of maximum acuity are shown at 1-, 2-, 3-, 5-, 7.5-, 10-, 15-, and 20-min. time intervals in the table. The conclusion seems warranted that 20 min. of adaptation ought to be allowed after donning the red-green acetate goggles, since, with such a period of adaptation, the acuity of the observers reaches approximately 90 per cent of its ultimate maximum.

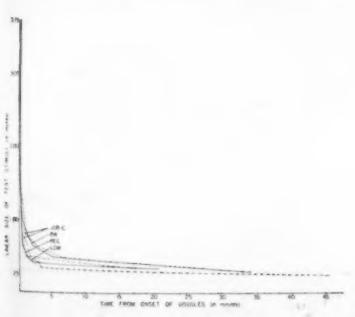


FIG. 21. Time required for four observers to see test stimuli of different sizes while wearing red-green goggles.

The Problem of Safety

More important from the practical point of view than any of the problems above is the problem of safety. The issue here is the extent to which the green acetate alone interferes with effective vision. This interference must be slight enough so that the instructor, who is looking through the green acetate alone, can adequately control the plane in case of necessity.

First Series of Experiments

In a first series of experiments, visual acuity and depth perception in full sunlight were compared for vision without a filter and for vision through Lumarith Green 0-4403, with an overall transmission of 0.191 in terms of tristimulus Y values with illuminant "C."†

The apparatus used for the test of acuity was essentially the same as that used in the study of individual differences. The test board was 200 ft. from the observer. Three observers took part in the acuity tests. The results showed that, for an outside illumination of 3,300 to 6,700 foot-lamberts, the average acuity for all observers through the green filters was decreased, relative to acuity without filters, by the same amount as would the acuity of a normal observer for a decrease of brightness of 1 log unit. As the density of the green filter reduced brightness by 0.72 of a log unit, it appeared that the effect to be expected from it on the basis of decrease in brightness alone—i.e., the effect attributable to color as distinct from brightness—was slight.

The apparatus used for the test of depth perception was an indoor model (scale about 1/10) of the field apparatus used in the principal validation tests. In the case of three observers, and using the Constant Error and Standard Deviation of settings as a criterion, no consistent difference was found between depth perception with the naked eye and depth perception through the green acetate.

† Measurements made at the Massachusetts Institute of Technology.

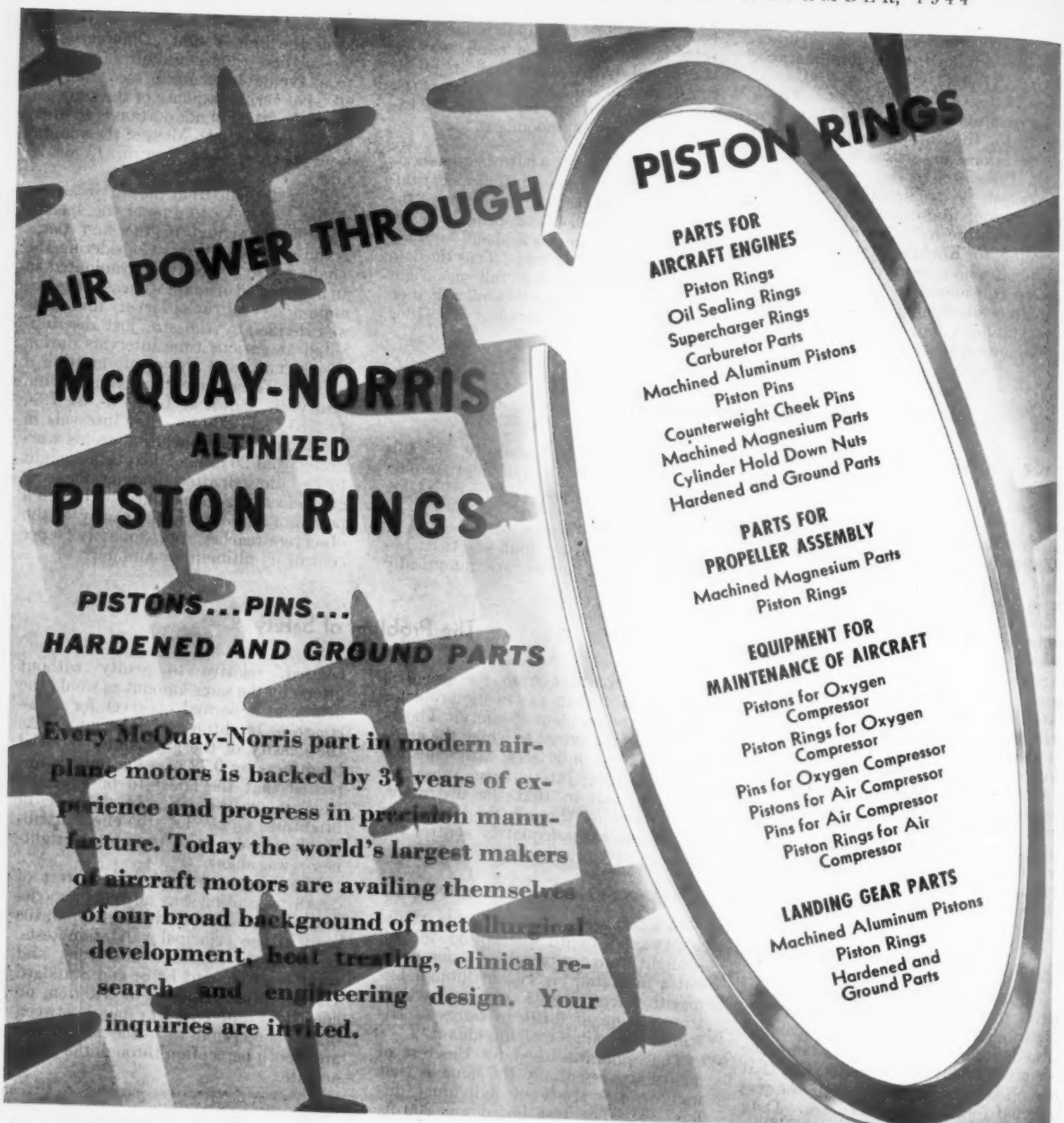
Second Series of Experiments

A second series of experiments was performed to ascertain the effect of the green filter on acuity during the transition from daylight to dusk. The procedure was essentially the same as that in the experiment described at the beginning of this section. The principal

TABLE 2

Percentage of Sizes Discriminated in an Hour Period of Dark Adaptation at Various Intervals During the Hour

Subject	Terminal Size	Percentages at Minutes 1	2	3	4	5	7.5	10	15	20
J. G. B-C.	0.35	43.8	49.3	54.7	58.3	62.5	71.4	73.7	80.5	87.5
J. G. B-C.	0.35	49.7	70.0	72.9	73.7	74.5	77.8	82.4	93.3	100.0
B. W.	0.30	35.5	44.4	49.2	52.6	57.7	62.5	63.8	68.2	75.0
R. E. C.	0.25	43.5	53.2	58.8	71.4	73.5	74.6	76.9	78.1	83.3
L. C. M.	0.35	66.0	81.4	83.3	84.3	87.0	88.6	89.7	94.6	99.5
Average	0.32	47.7	59.7	63.8	68.1	71.4	75.0	77.3	82.9	89.1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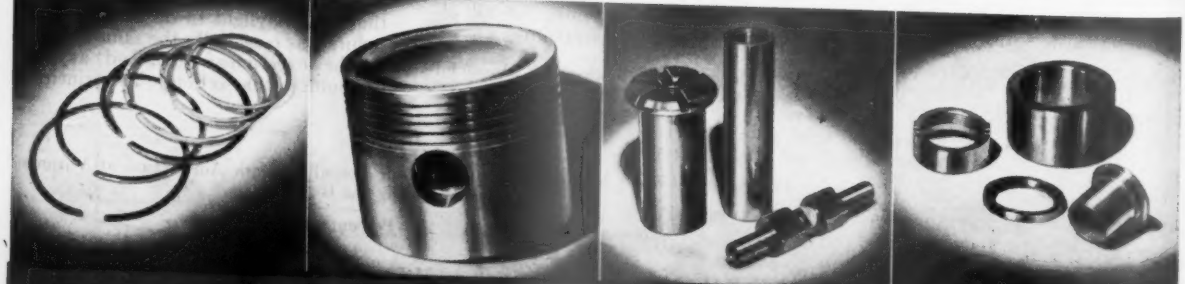

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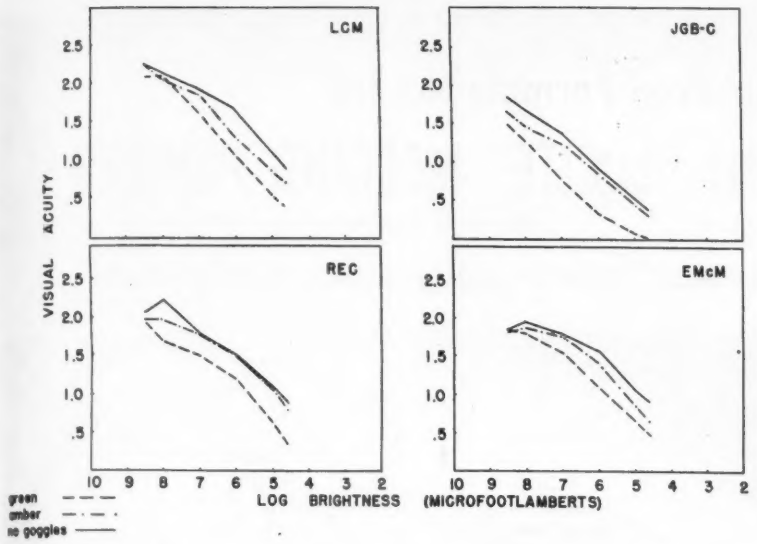

FIG. 22. Visual acuity as a function of brightness for vision through green and amber filters and for clear vision. Curves are averaged from four observers.

differences were: (a) An additional testboard was used to provide large symbols for the measurement of low acuities and (b) acuity through the green filter was compared not only with acuity without a filter but also with acuity through an amber filter.

The average results for four observers are shown in Fig. 22. It will be noted that for the green filter there is a loss of acuity that goes through a maximum for a brightness level of about 6 log μ foot-lamberts. If the losses of acuity, however, are estimated in terms of the decreases of brightness that would produce them (horizontal distances between the "filter" curve and the "no filter" curve), we find considerable constancy. Use of the green filter affects acuity at external brightnesses of 8.5, 8, 7, and 6 log μ foot-lamberts as though it cut down brightness, respectively, by 1.0, 1.1, 1.19, 1.08 log μ foot-lamberts. The previous series of experiments showed that, for high brightnesses, loss of acuity due to the green filter corresponded to a brightness decrease of 1 log unit. It seems reasonable to conclude that, for brightnesses down to 6 log μ foot-lamberts, Lumarith Green 0-4403 affects acuity in the same way as would a drop of brightness of 1–1.19 log units.

This decrease in acuity is at all brightnesses somewhat greater than would be expected from the decrease in brightness due to the transmission factor. The additional decrease may be due to a color factor, to scratches or smudges on the filters, to some characteristics of the acetate, or to discomfort of the goggle frames.

It would seem likely, on purely theoretical grounds, that the effect of decrease in brightness is the same whether this decrease results from nightfall or from heavy overcast. Nevertheless, it was thought wise to verify this interference experimentally. Visual acuity of three observers was tested on two dark days, one drizzly, the other rainy. The procedure was similar to that outlined above except that on the rainy day only one test board was used.

Comparison of the averages of acuities in overcast weather to the averages of acuities during the nightfall showed no significant differences. We may conclude that decrease in brightness due to overcast weather affects acuity in the same way as decrease in brightness during nightfall provided, naturally, that rain or fog is not acting as a screen between the object of vision and the observer.

Minimum Brightness Level

In order to state in full the practical import of these conclusions, it will be necessary to know the minimum brightness level that experience has shown to be safe for ordinary landing. We have not yet been able to obtain such data. We have found, however, that a test patch that, in full sunlight, had a brightness of 9.81 log μ foot-lamberts, had in the early afternoon of an intermittently rainy day a brightness of 8.16 log μ foot-lamberts; this represents a decrease of brightness of 1.65 log units. This decrease in brightness is considerably greater than that caused by use of the green acetate. As far as we know, overcast weather (as distinct from hazy weather) is not considered an impediment to flight. Assuming this to be the case, we may conclude that, in sunlight illumination, vision through the green acetate does not interfere with flying.

Although our data do not allow the specification of the minimum illumination at which it is still safe to use vision through green acetate, they do enable us to state the effect of the acetate, for various levels of brightness, in terms of decrease of the distance at which a given object can be distinguished, for this distance is directly proportional to acuity. Table 3 shows, for each of six brightness levels, the average acuity of the four observers with and without a green filter; the difference between these acuities; and, under the heading "percentage by which range of vision is cut down," the percentage that the difference in acuities constitutes of the acuity without a filter. The table shows clearly that, with respect to percentage decrease of range of vision, the effect of the green filter increases markedly with decrease of level of illumination. It should constitute a warning, pending establishment of the minimal illumination consistent with safety, against any attempt to use the green acetate filter on heavily overcast days (brightness level of about 8 log μ foot-lamberts) or in twilight.

TABLE 3

Brightness in Log μ Foot-Lamberts	Acuity Without Filter	Acuity with Green Filter	Difference	Percentage by Which Green Cuts Down Range of Vision
8.5	2.00	1.86	0.14	7.0
8.0	1.99	1.71	0.28	14.0
7.0	1.74	1.35	0.39	22.4
6.0	1.41	0.92	0.49	34.6
5.0	0.95	0.48	0.47	49.5
4.0	0.75	0.30	0.45	60.0

Specification of Red and Green Filters

Measurement of Transmission

In much of the work described above accurate measurement of luminous transmission was not crucial. The problem was essentially to establish certain characteristics of vision through the combination of a specific sample of green acetate and a specific red lens. Only in certain interpretations of the results was it necessary to know the luminous transmissions involved.

As soon, however, as the question arises of making use of the knowledge gained, the problem of measuring transmissions becomes extremely important. Practical specifications—including statements of tolerance—can obviously best be made in terms of luminous transmission.

It might seem at first glance that the problem of measuring transmissions is a relatively simple one, in view of the existence of such excellent spectrophotometers as that of Dr. Hardy at M.I.T. We have indeed secured from M.I.T. spectrophotometric curves for the green and red filters separately,

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whose density is on the order of 0.73 and 0.97, but not for the combination of red and green, whose density is on the order of 5.70. For this low order of transmissions, resort has had to be made to photometric measures.

Photometric Procedure

The photometric procedure used consists essentially of two simultaneous measures of the brightness, one with the Macbeth Illuminometer, the other with the Taylor Low-Brightness photometer. The source of illumination is in both cases the same, a large white test patch normal to the sun. In the case of the Macbeth Illuminometer the measurement is made in the usual way. In the case of the Taylor instrument, however, the filters whose transmission is being ascertained are placed in a slide affixed to the end of the photometer in such a way that the test patch is observed through the filters. In consequence, this procedure yields two simultaneous measures of brightness of the test patch, one of the brightness without interposition of filters, the other of the brightness with interposition of filters. The ratio of the latter, representing light transmitted by the filters, to the former, representing light impinging on the filters, is taken to represent the transmission of the filters.

In one of these measures of brightness, that with the Taylor instrument, the color of the comparison field is definitely more red than the color of the standard field. This would not be an important consideration if the comparison were purely photopic. The Taylor readings, however, vary from about 4.5 log μ foot-lamberts to 2 log μ foot-lamberts. At these levels of brightness, rod vision is involved and it is all the more involved the lower the level. Several consequences follow from this state of affairs: (a) With daylight illumination transmissions measured by this procedure are lower than if measured with a physical photometer designed to reproduce photopic sensitivity; (b) with daylight illumination transmissions measured by this procedure are lower when the operator of the Taylor instrument is fully dark-adapted than otherwise; and (c) transmissions measured by this procedure are lower for daylight the lower the illumination on the test patch.[7]

Circumstance (a) is an advantage for the procedure being described because the pilot will be using scotopic vision too; consequently, the transmission figure based on scotopic sensitivity will represent transmission of the filters when actually used.

The combination of circumstances (b) and (c) requires the use of a special installation for making the photometric measurements. According to (b) the operator of the Taylor instrument must be dark-adapted. According to (c) the test patch must be in sunlight, for it is in sunlight that the filters are used in the training of pilots. A lighttight cabin was constructed on the roof of the Tufts Chemistry Laboratory. Two juxtaposed circular openings allowed two operators from within to aim the two photometers almost normally at an external test patch attached to the cabin by means of an arm. The whole cabin could be rotated to maintain an approximately constant normal orientation of the test patch to the sun. In consequence, the test patch could be used in direct sunlight without interfering with the adaptation of the operators using the photometers.

Choice of Green and Red Filters

The joint transmission of the green and red filters used in the validating experiments was found to be 0.00000377. Combinations of other samples of the two materials, however, gave joint transmissions varying from 0.00000081 to 0.00000527. It was clear, both from this observed variability and from the statements of the manufacturers, that neither of the two filter materials was wholly standardized. This circumstance implied that if uniform results were to be obtained the materials would have to be specified in terms of transmission.

The considerations bearing on the specification of the filters were, in the main, as follows:

(a) The joint transmission of the red and green should be no higher than about 0.0000020 in order to make sure that the combination would reproduce night conditions in full sunlight, the illumination in which it would usually be used.

(b) The joint transmission of the red and green should be such that sunlight seen through the filters should not have a reddish tinge.

(c) The transmission of the green should be as high as possible in order to minimize interference with the vision of the instructor.

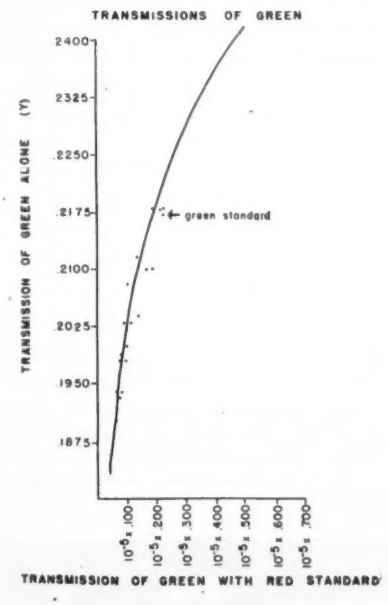

Fig. 23. Effects of variation of transmission of green filter on joint transmission with red filter.

At first glance, it would seem that these considerations all point in the direction of selecting an extremely light green and placing on the red the burden of darkening the combination. This semblance, however, is erroneous. For the types of filters under consideration the combination yields a red hue not only when a red of high transmission is combined with a green of low transmission but also when a red of low transmission is combined with a green of high transmission. This is because darkening the red filter decreases its transmission not only for red light but for green and yellow as well. The latter effect preponderates in the determination of hue. Thus, the requirement that the hue of the light transmitted by the combination of filters shall not be red makes it necessary to choose for the specifications a red whose transmission is not markedly different from that of the red used in the validation experiments.

Final Combination

The combination finally decided upon was a Lumarith Green 0-4403 with an average transmission (tristimulus Y value, illuminant "C") of 0.2170 according to measurements at M.I.T. (green standard) and a Polaroid XR-12 that, when combined with the green mentioned above, would yield an average combined transmission of 0.0000026 (red standard). The way in which this decision was reached was as follows: On the basis of general considerations involving the criteria above, a specific sample of Polaroid XR-12 was selected as the red standard. Joint transmissions were then determined for combinations of this red standard with 26 green samples representing the range of transmissions of green Lumarith that Celanese considered might be appropriate. From these data a graph was prepared (Fig. 23) showing the way in which the joint transmissions of the greens with the standard red varied as a function of the transmission of the green alone. Inspection of this graph showed that, for green Lumarith to have a joint transmission of 0.0000020 when combined with red, its transmission alone should be 0.2170, according to the method of measurement used by M.I.T. Sample No. 8 of green Lumarith came extremely close to fulfilling this condition. In consequence, it was chosen as the green standard. The joint transmission of this green standard with the red standard was then determined empirically in a large number of tests and found to be 0.0000026.

Tolerances

The next problem was that of tolerances. In regard to the red filter, photometric measurements of 20 goggles in which the red and the green were laminated together showed that 60 per cent of the goggles had transmissions between 0.0000015 and 0.0000024. As there was evidence that the green in

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these goggles was remarkably constant, the range was presumably indicative of the control over transmission to be expected in the manufacture of the red filters. Need for haste in the procurement of goggles made it desirable to extend somewhat the range indicated above. It was decided, eventually, to ask Polaroid to deliver XR-12 red lenses that would, when combined with the standard green, yield joint transmissions within the range 0.0000015–0.0000034. Practical considerations made it desirable to define tolerance in terms of concrete filters rather than transmission figures. Two red filters were therefore selected. Their joint transmissions, when combined with the green standard, were, respectively, 0.0000015 and 0.0000034, and Polaroid was asked to supply goggles which, when tested with the standard green, would yield transmissions falling between transmissions yielded by these two filters.

In regard to the green acetate, Celanese Corporation reported that it could hold deliveries within a range of overall transmissions of 12.5 to 15.9 per cent in terms of its own measurements, equal to a range of 0.1842 to 0.2209 in terms of M.I.T. tristimulus Y values. Celanese further supplied samples of the extremes of this range. Measurements were made of the joint transmissions of these samples and of the standard green when combined with the standard and the lightest and darkest reds involved in the specifications to Polaroid. Furthermore, the combination of darkest green and darkest red was tested with respect to perception of objects in sunlight illumination.

Fig. 24 shows the joint transmissions of the combinations of the three reds with the three greens. The range of these transmissions is from 0.00000049 to 0.00000505, which represents a difference in brightness of just over 1 logarithmic unit. Assuming the brightness level of full sunlight to be 9.81 log μ foot-lamberts, the brightness level of full sunlight seen through the combinations representing the extremes of the range would be 3.50 and 4.51 log foot-lamberts. According to Fig. 9, the higher of these brightnesses is not so high but that, for it, depth perception is definitely impeded. For the lower of the brightnesses the effect on depth perception is extremely marked.

As regards the general effect on perception of the combination of darkest green with darkest red, it was found that when used in sunlight after 15 min. of adaptation, the combination yielded

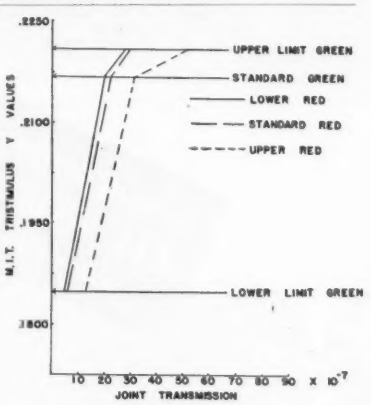

FIG. 24. Joint transmission of upper, standard, and lower red filters as a function of transmission (Y value) of upper, standard, and lower green filters.

vision comparable to night vision with weak moonlight. Buildings could be distinguished up to about 150 yards, but only vaguely.

Because of these findings, it was decided that the tolerance proposed by Celanese was acceptable insofar as vision of the pilot was concerned.

There remained, however, the question of the effect of the tolerance on the instructor. Here the question was: Is the darkest green still light enough to allow adequate vision for the instructor?

In the tests described above on the effects of green acetate on daylight and twilight vision, the overall transmission of the acetate, in terms of M.I.T. tristimulus Y values, was 0.191. The overall transmission of the lower limit proposed by Celanese was, in terms of the same units, 0.1842. The difference corresponds to a decrease of brightness of 0.016 of a log unit that is only $^1/_{100}$ of the difference in brightness between sunlight and heavily overcast weather. It seemed reasonable to consider this difference insignificant and to conclude that the tolerance proposed by Celanese was also acceptable from the point of view of the instructor's vision.

In consequence, Celanese Corporation was asked to supply Lumarith Green 0-4403, 10 gauge, average overall transmission 0.2170 (tristimulus Y value, illuminant "C," measured by Professor Hardy's recording spectrophotometer at M.I.T.), tolerance to be that the joint transmission with the Polaroid red standard should fall between the corresponding joint transmissions for sunlight of the samples labeled: "12.2–12.6" and "15.9" by Celanese.

CONCLUSION

The main conclusion to be drawn from this work is that conditions of night flying can be reproduced in daylight for the pilot without excessive interference with the instructor's vision by using an appropriate combination of red and green filters.

This conclusion, however, should be thought of as a validation of the general procedure involved,* rather than as a demonstration that the particular filters used constitute an optimal combination. There is much room here for further research, and only with such further research can the general procedure achieve the maximal efficiency of which it is capable.

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* The principle of mutual exclusion of colors has recently been applied to the problem of black-out by Wank and Wakefield.[8]

Changes of Address

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Lightweight Magnetic Direction Indicators

G. M. GIANNINI*

Autoflight Corporation

ABSTRACT

Autoflight Direction Indicators weigh only 1.1 and 0.5 lb., respectively, are comparatively inexpensive, and, unlike conventional card compasses, are read by means of a rotating pointer operating like a watch hand. They are unaffected by rough air.

The operating characteristics of the instrument have been obtained by combining a low mass of the magnetic system and a small diameter of moving parts to reduce overswing; a high magnetic moment to reduce the time of swing, or period; a low drag and a high damping to reduce swirl. This damping is obtained by utilizing the drag induced by the pointer rotating within the narrow chamber comprised between the dial and the front glass.

The combination of the proper value of period, overswing, swirl and the freedom from effects of vibration provide the excellent performance characteristics of these indicators.

INTRODUCTION

THE COMPASS may be considered the most important instrument on small airplanes not equipped with gyros and automatic pilots. Compasses used on aircraft are substantially of two types—conventional card compasses and direction indicators. The conventional card compass presents a number to be read through a window, as seen in certain types of automobile speedometers and in radio dials, while the direction indicator gives a quantitative measurement of direction by means of a rotating pointer operating like a watch hand. Irrespective of numerals on the dial, direction may be read at a glance. It may be noted that while marine compasses have always used pointers or their equivalent, aircraft compasses were designed when automobile speedometers without pointers were in vogue. This design was unfortunate, since in an airplane, where the eyes of the pilot are generally focused for distance and where rapidity in acquiring information is of the utmost importance, valuable time may be lost in focusing the eyes on an instrument and then focusing again on the horizon.

Several other advantages are apparent in the use of a direction indicator. The pilot may, for example, draw an imaginary line on his chart parallel to the instrument-pointer readings. Without further calculation he will have his magnetic course, drawn according to the conventions of cartography, locating the north at the top. With the card compass, azimuth readings increase from right to left, making the interpolation of intermediate values difficult and often inaccurate. Unlike the card compass, the direction indicator causes the pointer to swing to the right when the aircraft makes a turn to the right, and vice versa.

To summarize, the pilot must perform seven distinct steps in the use of a card compass: (1) Locate compass with unfocused eyes; (2) focus eyes; (3) read numerals; (4) interpolate values between two numerals; (5) translate value read into a direction; (6) correct course when necessary; (7) refocus eyes to horizon. With a direction indicator there are only four steps to follow (in emergency the second step may be omitted): (1) Locate compass with unfocused eyes; (2) focus eyes; (3) glance at the direction of the pointer; (4) correct course when necessary. It is known from experience to date that, although pilots may be trained without undue effort to use a card compass, a great deal of valuable time may be saved for attention to other instruments by the substitution of a direction indicator.

GENERAL DESCRIPTION

Autoflight Direction Indicators were designed to be used both on air liners and on light airplanes to replace bulkier types of direction indicators, as well as to replace the conventional card compass. The number of parts was reduced, simultaneously reducing weight and cost and improving performance. The foregoing policy of simplicity aroused military interest, and the indicators have found application on military aircraft. The larger instrument, with $3^3/_4$-in. dial, is made up of only 45 parts and weighs 1.1 lbs.; the smaller, with $1^7/_8$-in. dial, is the first of its kind, weighing only 0.5 lb.

Fig. 1 shows the larger Autoflight Direction Indicator as it appears, with a 360° vertical dial graduated in 2° divisions, permitting readings to $^1/_2$°. The heading of the aircraft is indicated by a rotating pointer, and readings are visible within a 120° solid angle. The course-setting lines parallel to the pointer are operated by an adjusting knob on the front face of the compass. The smaller direction indicator is entirely similar in appearance except for the absence of the course-setting lines. Operation of both models may be easily followed by referring to the cutaway view in Fig. 2, which shows the larger mechanism and applies equally in principle to the smaller.

Fig. 2 shows the housing, comprising an upper and lower chamber. The upper chamber contains the operating mechanism proper, which is mounted on a frame; the lower chamber contains an expansion bellows to compensate for altitude effects of pressure. The housing is entirely filled with compass fluid through a hole located in the rear top, and the magnetic compensator is mounted on top of the housing. The operating mechanism comprises two shafts mounted on a cast-aluminum frame—one horizontal and one vertical. The horizontal shaft carries the pointer at the front and a bevel gear at the rear end; the vertical shaft carries a bevel gear at the bottom and a gimbal coupling to which the magnetic system is attached at approximately the midpoint. The shafts are supported by two jewels each, with osmium-alloy pivots. The magnetic system includes

FIG. 1. Autoflight direction indicator.

Presented at the National Light Aircraft Meeting, I.A.S., Detroit, April 27-28, 1944.

* President.

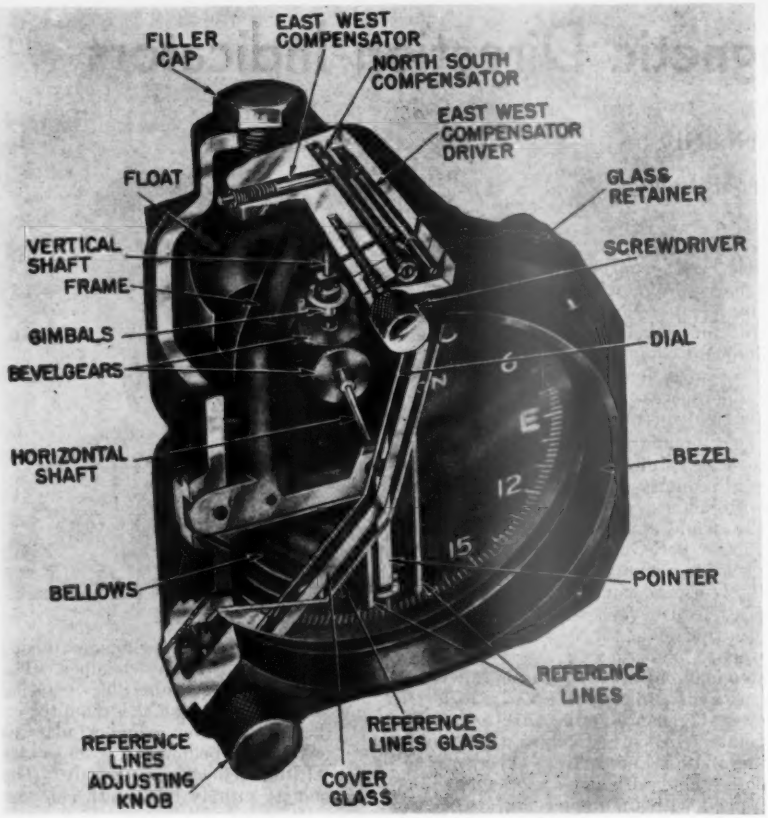

FIG. 2. Cutaway view of Autoflight direction indicator.

an annular float, supporting two Alnico magnets, which rotates within the aluminum frame. The magnetic system and the pointer are thus linked through the gimbals and the vertical shaft and through the bevel gears and the horizontal shaft.

PERFORMANCE CHARACTERISTICS

Autoflight Direction Indicators meet Army Air Forces' specifications and are extremely accurate and reliable. Both instruments combine a short period with low overswing and low swirl over a wide range of temperatures. Freedom from vibration effects and negligible friction characteristics permit a smooth, continuous action requiring no tapping, even during power-off glides. A minimum dynamic unbalance of the magnetic system insures satisfactory performance when the instrument is located away from the center of gravity of the aircraft.

Period

Since large mechanical torque is required to drive the pointer and card shaft mechanisms and since only a small space is available for the card system because of the front mounting requirements of the instrument, a high magnetic flux to float volume ratio has been provided. The torque exhibited by conventional linear magnets varies both with the aspect ratio of the magnets and with their separation. Fig. 3 shows the variation of flux density with aspect ratio. To give short period, an optimum value of flux density was selected within the limits of the float volume permitted.

Overswing

Since the mass of the float itself is small and the radii of gyration of the peripheral mass of the float are small, the overswing of the float and card system is necessarily small. No fins or other means to couple the card to the fluid are needed, which, while reducing overswing, increase the period and swirl. The continuous mechanical coupling between float and pointer prevents "hunting" common to other types of coupling and permits the use of comparatively small magnets.

Stability in Rough Air

Stability of the float is achieved by static and dynamic balancing of the pointer shaft and pointer; moreover, the card shaft and pointer shaft move in planes at right angles to each other. The fluid-filled chamber serves as an aperiodic damper, since the fluid is forced by the rotation of the pointer between the pointer itself and the dial and glass surfaces, respectively. Since the damping effect is roughly proportional to the speed of the pointer and since the mass of the pointer is very small, a low overswing is achieved.

Performance of these instruments under actual flight conditions shows good stability under pitch on a west heading, roll on a north heading, yaw on an east-west acceleration, and northerly turning error from south to north through west. Fig. 4 shows a comparison of the performance of compasses during roll on a north heading.

Vibration Effects

Vibration effects are minimized by a dynamic balancing of float mass together with the vertical and horizontal shafts and by a decoupling of the float system and the shaft systems. It is known that when a system comprising a vertical and a horizontal shaft is subjected to a typical vibration at a 45° angle, each shaft may be made to rotate. This rotation occurs because a polished shaft within a jeweled bearing will, even

(*Continued on page 43*)

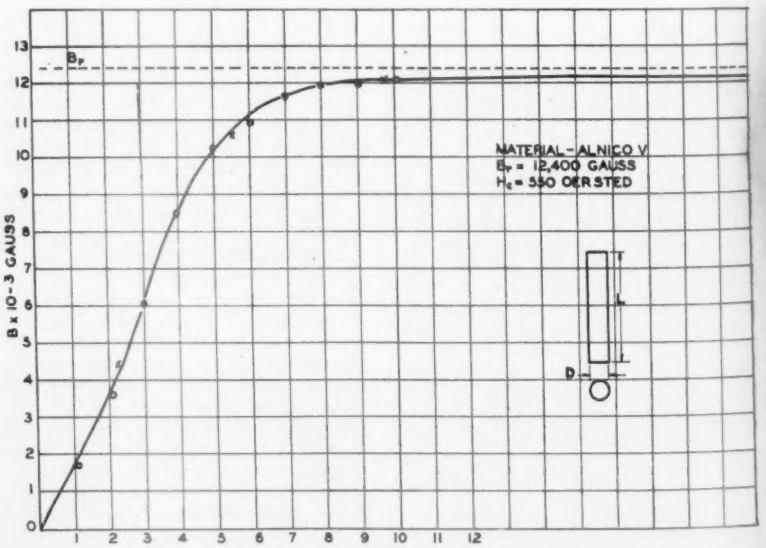

FIG. 3. Variations with aspect ratio of flux destiny in bar magnets.

The B.F. Goodrich Airplane of the month

BOEING B-29 SUPERFORTRESS

SUPERLATIVES have always been used, and often too freely, in describing new warplanes. For the B-29, however, superlatives seem strangely inadequate. No one warplane has ever made such a startling debut or suggested such awe-inspiring potentialities as the Boeing Superfortress.

Little can be added here to the glowing tributes that have already appeared hundreds of times in the public press. Suffice it to say, this airplane is destined to write its own eulogy on the pages of history.

Every man and woman who helped make the B-29 possible shares abundant credit for a remarkable achievement. Adding one more handclap to a nation's applause, B. F. Goodrich salutes Boeing—names the Boeing B-29 Superfortress "Airplane of the Month."

In war or peace

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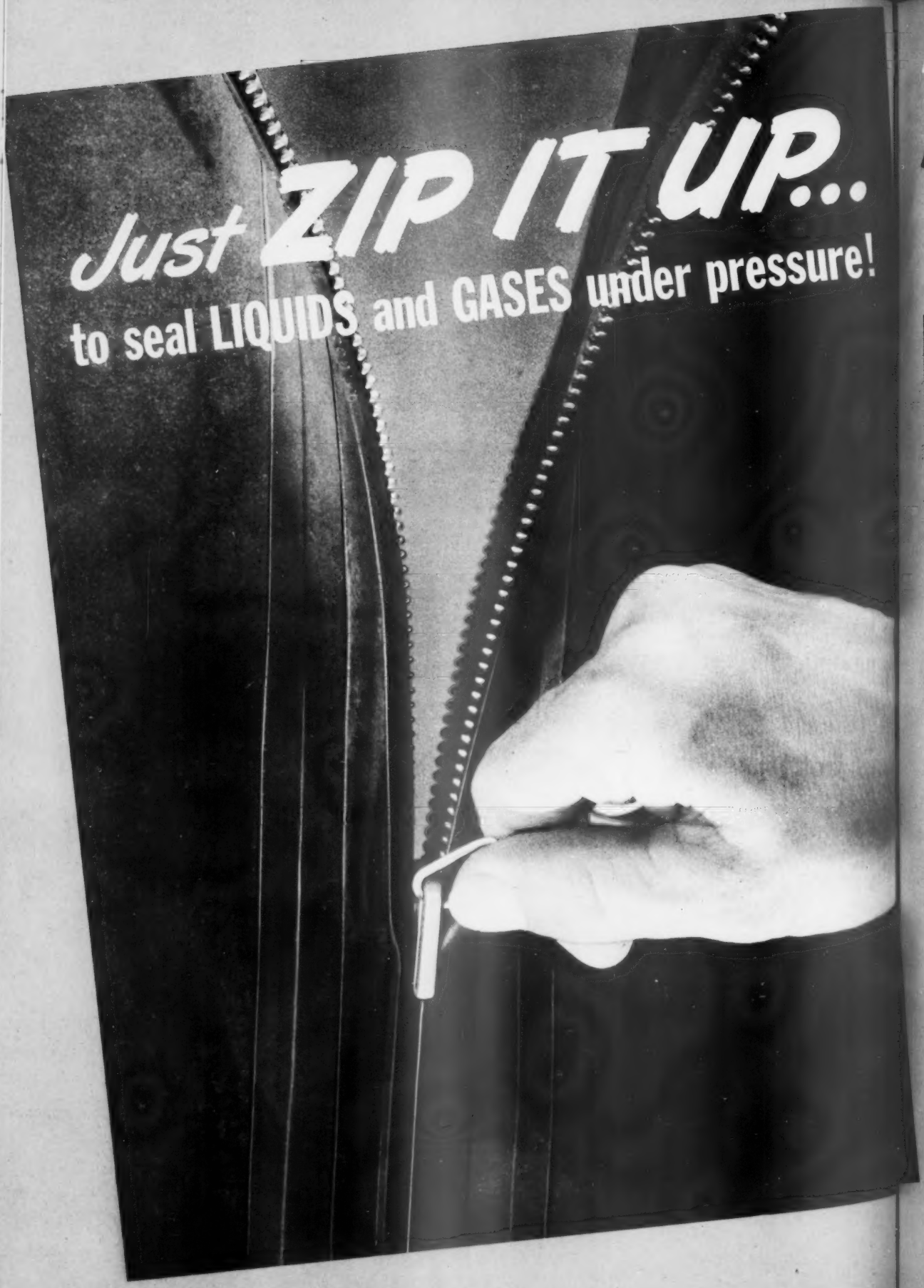
FIRST IN RUBBER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to seal LIQUIDS and GASES under pressure!

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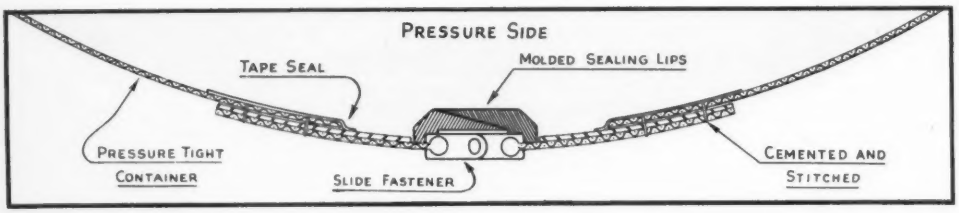

ONE of the newest products of B.F. Goodrich research is a zipper which won't let gases or liquids through, even under high pressure.

B. F. Goodrich engineers have taken a slide fastener and added a precision-molded rubber seal that opens and closes with the fastener. This seal is a unique arrangement of overlapping rubber lips which provides an effective and complete seal from zero pressures to pressures up to the structural strength of the fastener itself.

B. F. Goodrich Pressure Sealing Zippers can be applied to metal, fabric, or sheet rubber, provided a sufficient clearance is allowed for proper operation of the fastener. They may be installed by stitching or cementing, depending on application.

These zippers are effective in a wide temperature range. The rubber won't crack when bent at −70° F. nor become soft at 150° F. Weatherability is good; aging tests have shown present compound is best possible for this type of product.

Three types of B. F. Goodrich Pressure Sealing Zippers to choose from

Style 400: Non-Separating type seals throughout its entire length but is open at the top. It has a slider which can be operated from either or both sides. This type of closure may be used in applications such as exposure suits.

Style 410: Separating type; seals for entire length but not at ends. Slider operates from either or both sides. This type is now being used effectively as an aileron gap seal.

Style 420: Non-Separating type. Seals at both ends and along entire length. Slider operates from side opposite sealing lips. Originally developed as a closure for pressure vessels, it suggests many other interesting uses.

Aeronautical uses

Among the many uses suggested for this unusual closure are the following aeronautical applications: (a) For joining sections of both low- and high-pressure ducts. (b) Sealing doorways and hand-holes where there are pressure differentials. (c) Sealing bail-out kits and instrument cases. (d) Weather seals. Undoubtedly many more uses will come to our attention as people learn about the B. F. Goodrich Pressure Sealing Zipper.

Perhaps you may think of a use for it. Our engineers will be glad to call on you and discuss your applications. The B. F. Goodrich Co., Aeronautical Division, Akron, O.

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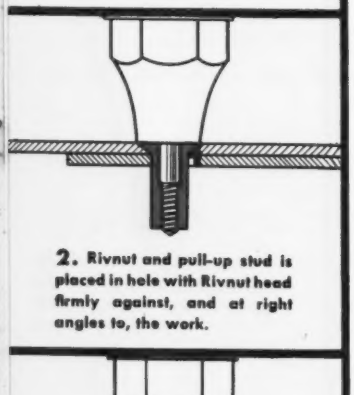
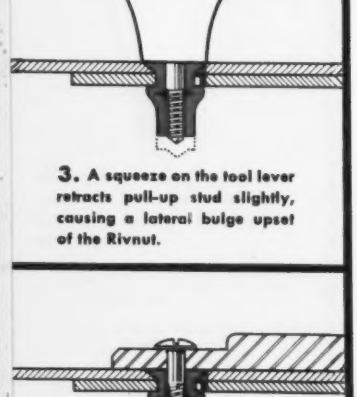
1. Rivnut is threaded on pull-up stud of heading tool until it touches the anvil.



2. Rivnut and pull-up stud is placed in hole with Rivnut head firmly against, and at right angles to, the work.



3. A squeeze on the tool lever retracts pull-up stud slightly, causing a lateral bulge upset of the Rivnut.

4. When pull-up stud is removed, the Rivnut can be used as a nut plate. Threads grip accessory screw firmly.

TWO NEW KINDS of B.F.Goodrich Rivnuts—Brass and Splined Aluminum—have recently been added to the line. Both of these new types, like the regular aluminum Rivnut, can be used as a blind rivet, as a nut plate for attachment, or as both at once. In addition, the new types have the same advantages as the standard Rivnut. They're simple in design (one-piece); they're compact—require a smaller hole yet have larger bearing area than any other blind fastener; they're ready for use as received. More complete information about each type is given below:

SPLINED ALUMINUM

This Rivnut is ideal for use as a nut plate in wood or plastics because the splined shank gives excellent torsion resistance. A full range of sizes and head types is available.

BRASS This is one of the newcomers—a stronger B. F. Goodrich Rivnut for blind fastening where greater tensile and shear strength is required (about 50% stronger than aluminum). Production now limited to sizes 6, 8, and 10. More sizes will be announced when available.

53-S ALUMINUM ALLOY This is the standard Rivnut originally designed for aeronautical use and now doing hundreds of fastening jobs. It is light, strong, corrosion-resistant . . . and so easy to install, even a blind man can do it. Full range of types, sizes, grips available.

For more facts, get "RIVNUT DATA"

Contains full information on Rivnut types, sizes, grip ranges, etc.—also step-by-step illustrated installation procedure. For your copy, write to The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.

B.F.Goodrich

RIVNUT

IT'S A RIVET...IT'S A NUT PLATE

Lubrication Ceiling

P. H. SCHWEITZER*

The Pennsylvania State College

SUMMARY

Gear pump delivery falls off with increasing altitude and above a certain point it fails to provide for the necessary engine lubrication. A simple equation is developed to calculate lubrication ceiling. Charts are presented to show the effect on lubrication ceiling of the following factors: (1) entrained air; (2) dissolved air; (3) pipe length; (4) pipe diameter; (5) tank height, pressure boost, valves and ells; (6) oil viscosity; and (7) pump speed.

According to the results obtained, a reduction of entrained air, dissolved air, and pipe resistance between oil tank and pressure pump have relatively small effects on the lubrication ceiling. Effective ways to raise the ceiling are pressurizing the oil tank and reducing the pump speed.

INTRODUCTION

OIL AERATION has various effects on engine lubrication. Some effects are plainly visible, such as foamy oil spilling over the crankcase breather; others are suspected, such as increased oxidation and reduced film strength in the bearings. However, the effect that at present seems to be troubling most people is the reduced gear pump delivery.

It has been shown by Dolza[1] and Pigott[2] that aeration at high altitude markedly reduces the delivery of the gear pump. It has also been pointed out that small diameter pipes, sharp bends, valves, and reducers in the suction line are harmful at altitude, especially in combination with entrained and dissolved air in the oil, and that conditions are aggravated by such factors as high oil viscosity and high pump speed.

* Professor of Engineering Research.

PUMP DELIVERY

In order to predict the pump delivery under a given set of circumstances, a formula has been developed which gives the delivery of the pressure pump (Fig. 1) as

$$Q = n\frac{V_{geo.}}{1 + d|(p_b/p_t) - 1| + e(p_0/p_t)} - \frac{}{S - B} \quad (1)$$

where Q is the oil delivery of the gear pump, cu.in. per min.; n, the pump r.p.m.; $V_{geo.}$, the geometric pump displacement, cu.in. per revolution; S, the slip or oil leakage, the value of which is around 3 per cent of the delivery; B, the back delivery due to oil trapping in the meshing teeth, the value of which is around 16 per cent of the geometric displacement; d, the dissolved air, per cent oil volume; and e, the entrained air, per cent oil volume, both under normal temperature pressure conditions; p_b, the pressure in the oil tank, which is close to the barometric altitude pressure unless the tank is pressurized; p_t, the pressure in tooth space; and p_0, the sea level pressure, 14.7 lbs. per sq.in.

The only obstacle to the ready use of Eq. (1) is the presence of p_t in the denominator which is not easy to evaluate.

Pump Losses

The tooth space pressure, p_t, is equal to oil tank pressure, p_b, plus tank height equivalent, less line loss, less pump loss. The line loss up to the pump flange can be calculated by the method described by Pigott.[3] It depends on the velocity of the flowing oil $v = Q/F$ and consists of two kinds of losses: the vee losses like pipe resistance, etc., and vee square losses like impacts, etc. The pump losses also consist of two sets of losses: the vee square losses in the pump housing, such as impacts, etc.,

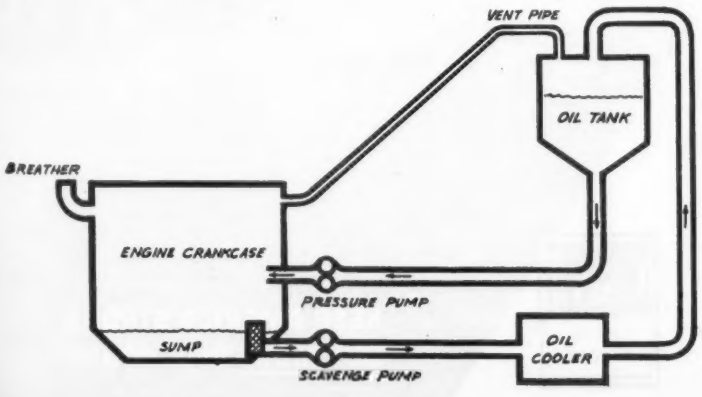


FIG. 1. Basic components of typical engine oil system.

and tooth entry losses, which in turn are composed of the centrifugal loss to overcome the centrifugal force exerted by the gear and the pickup loss, to speed up the oil to gear velocity. Of these losses the vee losses and vee square losses vary with Q/F and Q^2/F^2, respectively. The tooth entry losses vary as the square of the pump r.p.m. and as the first power of the oil velocity.

The presence of p_t in the denominator and its dependence on the velocity, $V = Q/F$, and velocity square, $V^2 = Q^2/F^2$, makes a cubical equation of Eq. (1), which can be solved with sufficient patience for any set of circumstances.

LUBRICATION CEILING

The pertinent question, however, is not how much the oil pump delivers but how high one can fly before the engine is distressed for lack of adequate oil supply. This problem seemed to be complicated but turned out to be quite simple. Eq. (2) evolved from Eq. (1) (see Appendix) is

$$p_b = PL(1 + d) + 14.7e \quad (2)$$

where p_b is the absolute barometric pressure at the critical altitude, lbs. per sq.in.; PL, the total pressure loss from oil tank to tooth space, lbs. per sq.in.; d, the ratio of the dissolved air volume (NTP) to the oil volume; and e, the ratio of the entrained air volume (NTP) to the oil volume.

This equation refers to a pump with zero slip and zero back delivery but otherwise normal. These assumptions have been made to simplify the formula. With, say, 3 per cent slip and 16 per cent back delivery, the effect of the various factors on p_b is practically the same.

From p_b by the known empirical relation (Fig. 2), the lubrication ceiling can be determined. Lubrication ceiling is defined as the altitude above which the pump delivery drops below the critical delivery, which in the present

TO FIGHT THERE AND BACK

In this war pilots often fight far over enemy territory, hundreds of miles from their base. So fighter planes need range as well as sting. ★ In such sorties the Allison engine has proved its mettle. Its economy adds miles to every tankful. Its dependability keeps it in the fight, helps get both plane and pilot back from hazardous encounters. Its smoothness and response lessen pilot fatigue. ★ Qualities like these will continue in importance after the war's end. They will contribute to the comfort and safety of your flights in the days of great air transport to come.

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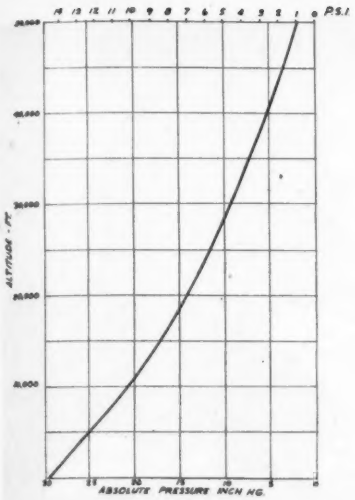

FIG. 2. Relation between atmospheric pressure and altitude.

case is 50 per cent of the normal delivery. For another percentage Eq. (2) is slightly different, as may be seen in the Appendix.

The application of Eq. (2) resulted in Figs. 3 to 9, which give both detailed facts and a perspective on the effects of various factors on the lubrication ceiling.

Only one variable was changed on each chart and the other variables were kept standard. The chosen standards were as follows:

Pump: W.A. external gear pump, 1.5 in. outside diameter, 0.963 root diameter, 2,600 r.p.m., delivering normally 16 gal. of oil per min.

Oil: An SAE-60 oil with 32.2 centipoise abs. viscosity at 180°F. and 1,293 centipose at 60°F.

Line from tank to pump and fittings identical to those described by Pigott[3] with a 1.134 in. inside diameter by 17 in. tubing, one ell, three nipples, and one valve.

Entrained air: 4 per cent of oil volume.

Dissolved air: 8 per cent of oil volume.

Pump speed: 2,600 r.p.m.

Oil temperature: 180°F.

These basic conditions correspond to those of a typical installation.

An inspection of these figures reveals some startling facts. Some of them may be characterized as of debunking nature.

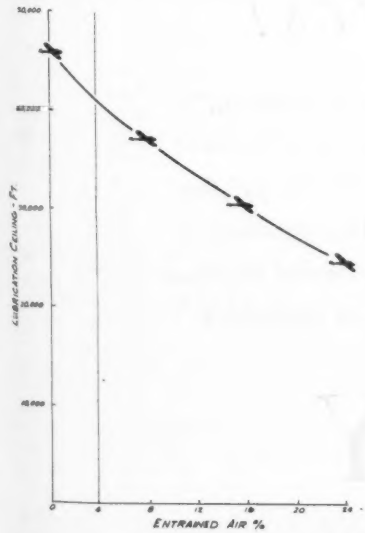

FIG. 3. Effect of entrained air on lubrication ceiling.

EFFECT OF ENTRAINED AIR

Fig. 3 shows the effect of entrained air and is in line with expectation. The lubrication ceiling is 46,000 ft. with 0 per cent entrained air and drops gradually to 24,000 ft. with 24 per cent entrained air. The entrained air is in the pipe between tank and pressure pump, and, because most of the air gets out of the oil in the tank, it must be a poor tank and cold oil if the entrained air is more than 8 per cent. Usually it is more

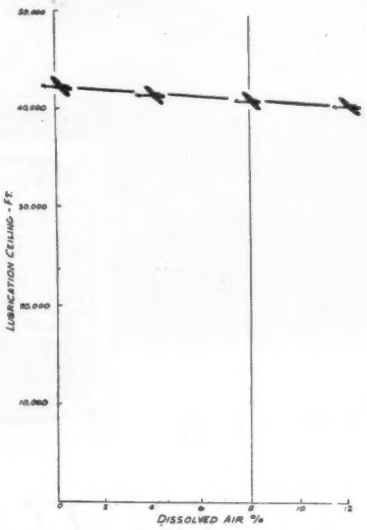

FIG. 4. Effect of dissolved air on lubrication ceiling.

like 4 per cent, which gives a 41,000-ft. lubrication ceiling under basic conditions.

The effect of entrained air can be stated very simply. Around 45,000 ft. altitude every additional 1 per cent aeration reduces the lubrication ceiling by 1,250 ft. irrespective of the pump and line resistance.

DISSOLVED AIR

Fig. 4 shows the surprising fact that the effect of dissolved air is so slight as to be negligible. The lubrication ceiling changes only from 42,000 to 40,000 ft. when the dissolved air increases from 0 to 12 per cent. The normal amount, according to our measurements, is 8 per cent. It must not be forgotten, however, that the effect of dissolved air would be greater if the pipe resistance

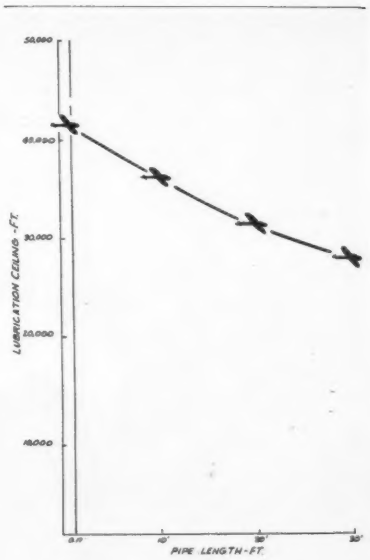

FIG. 5. Effect of pipe length on lubrication ceiling.

were greater. The curve refers to Pigott's 1.134 by 17 in. pipe and fittings.

PIPE LENGTH AND DIAMETER

Fig. 5 shows the effect of pipe length and is in line with expectation. Extremely long pipe is not good.

The effect of pipe diameter is shown on Fig. 6 and is surprisingly small in the normal region. By substituting $2^1/_2$ for 1.134 in. inside diameter tubing, the lubrication ceiling is raised from 41,000 to 42,900 ft. only. Of course, the fittings are supposed to be changed in proportion. The use of extra large pipe is therefore not justified.

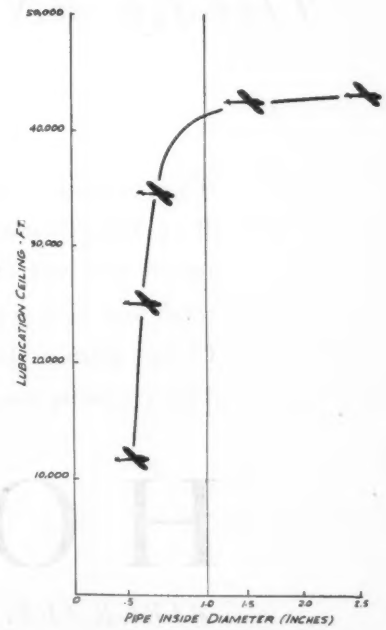

FIG. 6. Effect of pipe diameter on lubrication ceiling.

THERE AND BACK

. . . 121 TIMES!

This "censored" and mutilated carburetor serial plate from "Old 59," a B-25 Mitchell medium bomber, offers mute testimony in one of the most remarkable cases of carburetor dependability on record! ¶ "Old 59" flew there and back 121 times in bombing missions over Jap objectives in China—Burma—India—without a single instance of mechanical trouble. That's what we mean when we say, "Holley Carburetors are dependable."

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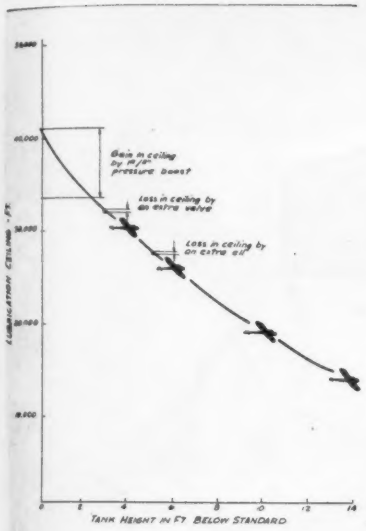

FIG. 7. Effect of tank height, pressurized tank, ells and valves on lubrication ceiling.

TANK HEIGHT

Fig. 7 shows the effect of tank height above the pump. Lowering the tank 2 ft. lowers the lubrication ceiling by 6,000 ft. It is immaterial whether the tank is lowered from 2 ft. height to pump level or from pump level to 2 ft. below pump level; the effect is practically the same. Of course, we are considering the lubrication ceiling with the pump in continuous operation. The fact that with a negative suction height one may have priming troubles is another story.

On the same chart the effect of an extra ell (90°) or an extra valve in the line is shown, both unexpectedly small. Neither of them reduces the ceiling by as much as 500 ft. Therefore, the avoidance, at all price, of ells and valves is not justified. On the other hand, pressurizing the tank to 1 lb. per sq.in. gauge raises the ceiling by 9,000 ft.

OIL VISCOSITY

Fig. 8 shows the effect of oil viscosity or temperature and is somewhat like what one would expect, except that the effect of heating the oil above 160°F. is insignificant.

PUMP SPEED

The effect of the pump speed is shown on Fig. 9. When the pump speed is raised from 1,000 to 4,000 r.p.m. the lubrication ceiling drops from 52,500 to 27,500 ft. This is considerable, even though it is realized that in order to have 16 gal. per min. normal delivery with low speed one must have a larger pump.

On all charts a vertical line marks the basic conditions and corresponds to a lubrication ceiling of 41,000 ft.

INCREASING THE LUBRICATION CEILING

The question may be asked, what is the ceiling with a perfect pump? Is it infinite? First it must be decided what is meant by perfect pump. If a perfect pump is defined as one that has zero slip and zero tooth clearance (zero back delivery), then the figures already refer to a perfect pump, but figures made up for an actual pump will not be much different. If, on the other hand, a perfect pump is defined as one with zero slip, zero clearance and zero pressure drop between pump flange and tooth space, the lubrication ceiling curves will be raised considerably. The ceiling is still finite.

With all pump losses being equal to zero the total pressure loss will be PL = 0.231 lbs. per sq.in. and

$$p_b = (1.08)(0.2315) + (0.04)(14.7) = 0.83 \text{ lbs. per sq.in.}$$

corresponding to a lubrication ceiling of 65,000 ft. On the other hand, if the total line resistance from oil tank to the pump flange were zero, with a standard pump the pressure loss would be PL = 0.8582 lbs. per sq.in., and

$$p_b = (1.08)(0.8582) + (0.04)(14.7) = 1.518 \text{ lbs. per sq.in.}$$

corresponding to a lubrication ceiling of 52,000 ft.

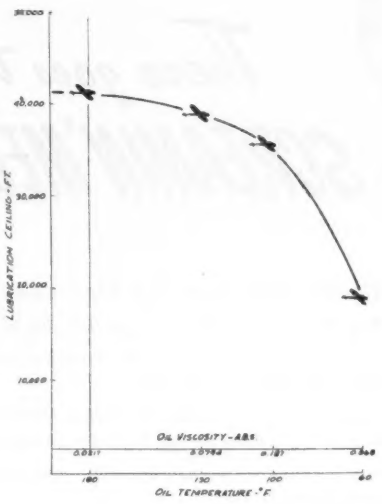

FIG. 8. Effect of oil viscosity on lubrication ceiling.

A conclusion to be drawn from the above analysis is that the greatest obstacle to raising the lubrication ceiling lies in the gear pump itself. This cannot be neutralized to any appreciable degree by minimizing line resistance or the percentage of entrained air.

The most effective simple way to increase the lubrication ceiling seems to be the pressurizing of the oil tank. One pound per square inch pressure in the tank raises the lubrication ceiling by 9,000 ft.

Table 1 shows the pressure losses from oil tank to gear teeth for normal (16 gal. per min.) and critical (8 gal. per min.) pump delivery.

TABLE 1
Line and Pump Losses, Lb. per Sq.In.

	16 Gal. per Min.	8 Gal. per Min.
Vee losses in line	0.2057	0.1028
Vee square losses in line	0.5148	0.1287
Total line loss	0.7205	0.2315
Vee square losses in pump housing	0.3528	0.0882
Tooth entry (n^2) losses		
Centrifugal loss	1.2300	0.6150
Pickup loss	1.8500	0.9250
Total pump loss	3.4328	1.6282
PL = total pressure loss from tank and tooth space	4.1533	1.8597
Vee losses	0.2057	0.1028
PL—vee losses	3.9476	1.7569
Vee square losses	0.8676	0.2169
PL—vee square losses	3.2957	1.6428
N^2 losses	3.0800	1.5400
PL—N^2 losses	1.0733	0.3197

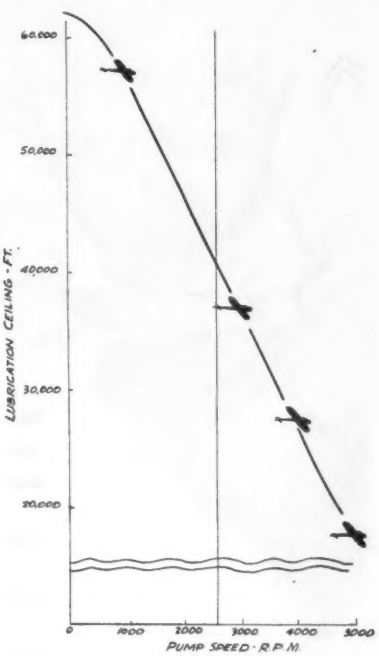

FIG. 9. Effect of pump speed on lubrication ceiling.

The figures in the table refer to the example calculated by Pigott,[2, 3] corresponding to the conditions specified previously. Sixteen gallons per minute represents normal flow, while 8 gal. per min. represents the critical flow, limiting the ceiling.

REFERENCES

[1] Dolza, John, *Correlation of Ground and Altitude Performance of Oil System*, Meeting of the Society of Automotive Engineers, June 8, 1942.

[2] Pigott, R. J. S., *Oil Aeration*, SAE Journal, p. 73, March, 1944.

(*Continued on page 43*)

There goes the SCREAMIN' MEEMIES

Bud: *Yea—four hours ago she limped in here with No. 3 engine all shot up.*

Jim: *Boy! We sure learned how to get those big babies back in service quick.*

Bud: *'Course, ya gotta hand it to Air Technical Service Command—sending those assemblies way out here.*

Jim: *O sure, but I get the jumps every time I think how we used to work 27 hours straight when we had to change an engine.*

Bud: *Now we just drop in a new assembly—a pipe four-hour job. Maybe we're gettin' good!*

Jim: *Blow it, fat-head. Here comes the Sarge.*

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[2] *Preliminary Calculations on Air-Oil Performance of Spur Gear Pumps*, Gulf Research and Development Company Report KG-OO of April 13, 1942 and Supplement File KGOO-I of January 17, 1944.

Appendix

See Eq. (1)* for the volumetric pump delivery. The slip S or leakage of oil between and around the gear teeth is a certain fraction of the total oil delivery, depending mainly on the oil viscosity, discharge pressure, and machining clearance in the gear pump. In an aviation-type pump pumping lubricating oil, it is of the order of 3 per cent. Generally it may be set as

$$S = s(Q/n) \tag{3}$$

where Q/n is the volumetric delivery per revolution.

The back delivery B is due to the clearance volume between the meshing gear teeth on the noncontacting side of the gear as was pointed out by Pigott.[2] The back delivery is a fraction of the geometric displacement and may be expressed as

$$B = bV_{geo}. \tag{4}$$

The value of b depends almost solely on the geometric clearance volume and is of the order of 16 per cent in typical gear pumps.

By defining volumetric efficiency as

$$VE = (Q/n)/V_{geo}. \tag{5}$$

from Eqs. (1), (3), (4), and (5),

$$VE = \frac{1}{1+s}\left\{\frac{1}{1+d[(p_b/p_t)-1]+e(p_0/p_t)} - b\right\} \tag{6}$$

is obtained. When, due to altitude, the volumetric efficiency of the pump drops to a critical value VE_{cr}, the plane has reached its lubrication ceiling.

Since the tooth space pressure is equal to oil tank pressure less pressure loss

$$p_t = p_b - PL \tag{7}$$

Eq. (6) can be written as

$$VE_{cr}(1+s) + b = \frac{1}{1+d\{[p_b/(p_b-PL)]-1\}+e(p_0/p_t)} \tag{8}$$

or

$$1 + d\left(\frac{p_b}{p_b - PL} - 1\right) + e\frac{p_0}{p_b - PL} = \frac{1}{VE_{cr}(1+s)+b} \tag{9}$$

which, with some algebraic transformation, yields

$$p_b = \frac{PL\left[1 - d - \dfrac{1}{VE_{cr}(1+s)+b}\right] - ep_0}{1 - \dfrac{1}{VE_{cr}(1+s)+b}} \tag{10}$$

Assuming for the sake of simplicity that both slip and back delivery are zero, then with $s = 0$ and $b = 0$, from Eq. (10)

$$p_b = \frac{PL[1 - d - (1/VE_{cr})] - ep_0}{1 - (1/VE_{cr})} \tag{11}$$

or

$$p_b = \frac{PL[(1/VE_{cr}) + d - 1] + ep_0}{(1/VE_{cr}) - 1} \tag{12}$$

which gives the required barometric pressure for the critical pump delivery. Assuming that the pump delivery becomes critical when the volumetric efficiency of the pump drops to or below 0.5, (that means one-half of the pumps maximum capacity), then Eq. (12) becomes

$$p_b = PL(1+d) + 14.7e$$

which is identical with Eq. (2) of the paper.

* Note: Although Eq. (1) has been obtained by deductive reasoning, its validity had been confirmed by test results obtained in the course of an experimental investigation on "Airlock and Foaming in Aero-Engine Lubrication System," sponsored by the National Advisory Committee for Aeronautics, at The Pennsylvania State College.

(*Continued from page 32*)

if the clearance is extremely small, exhibit a friction during part of the vibratory cycle and fall back to its point of departure during part of the cycle. In addition to the occurrence of this well-known phenomenon, it was also observed, first, that a nonmagnetized float and vertical shaft system would rotate continuously counterclockwise at a speed depending upon the mass of the float and the clearance between shafts and bearings and, second, that a pointer shaft system would rotate continuously clockwise depending upon the mass of the pointer, upon the thickness of the front chamber within which the pointer revolves, and upon the clearance between the shaft and the bearings. It may be noted that the resonance point for these rotations to start changes by varying the clearance between the shafts and the jewels: The smaller the clearance, the higher the resonant frequency at which rotation begins. However, it should also be noted that this method of remedying vibration effects is impractical in actual use because a point of excessive friction is reached before the resonant frequency leaves the operating vibrating range of 600–2,500 r.p.m.

Friction

Low friction was obtained since all bearings are immersed in compass fluid and are therefore continuously lubricated and kept free from contamination and corrosion.

The mechanism has full freedom at 20° tilt.

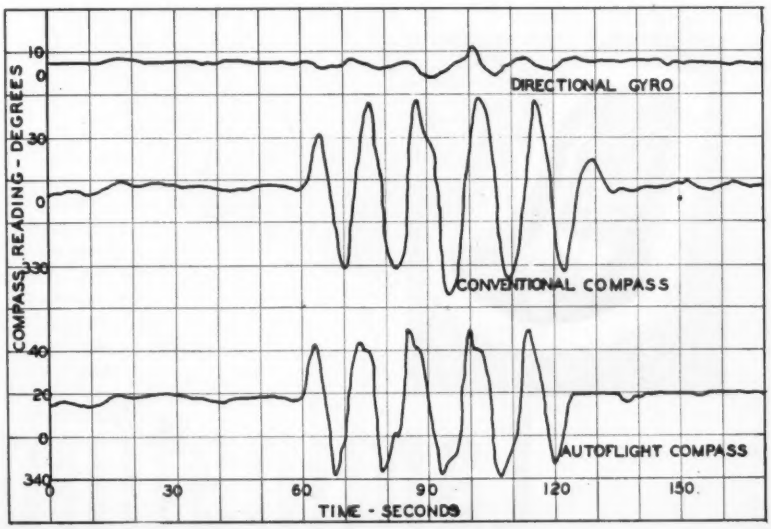

Fig. 4. Roll on a north heading.

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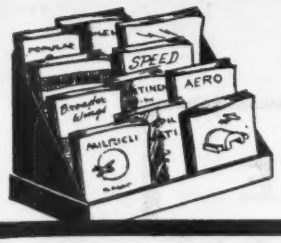

Periodicals

Accessories and Equipment

Selecting Aircraft Heating Equipment. Part I. Seymour E. Heymann. In Part I of a three-part article the writer discusses the requirements of exhaust-gas heat exchangers in the light of actual service experience. The study indicates that, where a heat exchanger is properly designed with respect to its various dimensions, little is gained by the use of passages of a particular shape—such as round, oval, or streamlined tubes. A mechanically sound design that is comparatively free from thermal stresses is the principal requirement. It is stated that a type of heat exchanger in which the exhaust gas passes through round tubes, which are assembled in bundles with flexible tube sheets at the ends, meets the requirements of large production installations. *Industrial Aviation*, September, 1944, pages 7, 8, 10–12, 8 illus.

Inserts Serve as Spark Plug Bushings. Robert Brooks. The function, construction, installation, and advantages of the Heli-Coil Spark Plug Bushing are described. This device is credited with obviating the need for removing the cylinder head to drill out the entire old bushing when replacing spark-plug bushings in aluminum-alloy cylinder heads of radial air-cooled engines. It is a helical coil insert of stainless-steel wire, accurately formed to engage fully with tapped threads in the cylinder head or salvaged bushing. By means of special tools provided by the manufacturer, Aircraft Screw Products Company, Inc., installation requires only the reaming out of the old or damaged thread, the tapping of a new thread, and the insertion of the Heli-Coil. *Aero Digest*, September, 15, 1944, pages 116, 173, 5 illus.

An Aircraft Pneumatic System. A brief description is given of the Hymatic high-pressure pneumatic system incorporated in the Heywood compressor type SH6/2, made by the Heywood Compressor Company of Redditch, Worcestershire, England. It can deliver pressures up to 850 lbs. per sq.in. It is described as a single cylinder, two-stage, reciprocating machine, designed for flange mounting on the engine or gear box. It is air cooled, weighs less than 5 lbs., and has a cylinder capacity of 45 cu.cm.

Constant driving speeds of 1,200 r.p.m. are attained by the compressor, but for short periods a higher speed can be reached. This greater speed would be used under power-dive conditions. The output, at ground level, is about $1^1/_4$ cu.ft. of air per min. at a pressure of 450 lbs. per sq.in. when operating at 1,200 r.p.m. The air reservoir can be recharged by the standard compressor at altitudes up to 45,000 ft., and these features make the compressor directly applicable to the requirements of combat aircraft, particularly high-altitude bombers or fighters. The first-stage pressure is arranged so that high-altitude atmospheric pressures are sufficient to refill the first-stage volume.

The operation of the compressor is described, as well as the lubrication, cooling, regulator valve, and the oil and water trap. *Aeronautics*, September, 1944, page 47, 1 illus.

A Report on Enemy Fuel Tanks. Information about various main fuel and header tanks taken from captured enemy aircraft is given in this article, which is based on a report of the Metallurgy Division of the Royal Aircraft Establishment. Descriptions are given of the Messerschmitt 109 header tank and fuel tank, the Heinkel 111 fuel tank, the Fiat Cr. 42 fuel tank, and the Focke-Wulf 190 drop tank. Sections deal with chemical analyses, mechanical test, microscopic examinations, accelerated-corrosion tests, and examinations of welds. *Aircraft Engineering*, August, 1944, pages 239–244, 12 illus.

Hydraulic Brake Control Valve. George A. Rix. A brief article discusses the design of hydraulic brake control valves. Instructions for operating these valves are given and diagrams illustrate the principles of operation. *Air Tech*, October, 1944, pages 32, 58, 4 illus.

Use of Rotary Pumps in Aircraft. Part I. H. J. S. Pigott. The characteristics of rotary pumps of the gear and vane type that make them widely adaptable to lubrication, fuel supply, and other uses in aircraft are discussed. This type of positive-displacement pump is compared with the piston or plunger type of reciprocating pump and with the centrifugal and turbine types, indicating the services for which each design is best suited as well as the advantages of each. The principal types of rotary pumps are named and various tests are described in detail. Methods are given for computing slip and mechanical losses and variation of slip. In addition to a theoretic analysis, two test methods are suggested for determining the per-

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formance of pumps, with particular attention to conditions prevailing at high altitudes. *Aero Digest*, September 1, 1944, pages 82–84, 124, 126, 9 illus.

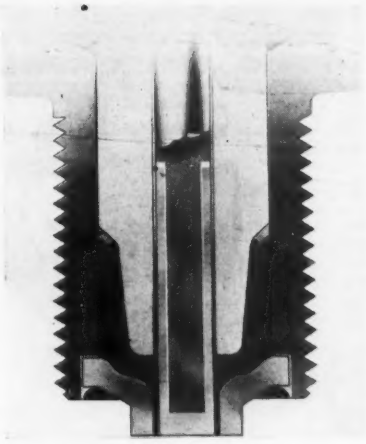
Fabricating and Installing Metal Tubing. F. G. Steele. The writer gives a detailed report on methods of fabricating and installing metal tubing materials in aircraft. Information is given about copper tubing for oxygen systems, aluminum tubing for conduit and ventilating systems, and stainless-steel tubing for hydraulic lines. Sections of the article discuss fabricating flared lines, installation factors, and torquing or tightening the nut on the line. Flexible hose is also discussed. *Industrial Aviation*, September, 1944, pages 50, 51, 54–56, 9 illus.

Lights that Talk. E. F. Lougee. It is noted that as the war has progressed many changes have been made in signaling lights for aircraft, and that many of these have involved the use of plastics. Aircraft lights in which plastics are used are described. Illustrations show an all-plastic cockpit light and the parts included in its construction, two-color plastic lenses for a bomb-release signal lamp, and a plastic indicator light that replaced an aluminum model. *Modern Plastics*, September, 1944, pages 101, 102, 184, 5 illus.

"Package" Motor-Control Units Facilitate Design. Parts I and II. William H. Fromm. An article about small built-in motor control units that have made possible precision control of fractional-horsepower motor operation. The text is not confined to aircraft applications but a considerable part of the information applies to this field.

Part I deals with motion control—that is, devices used to control the speed of the motor, including built-in governors, variable-speed transmission clutches and brakes and limit switches.

Part II has to do with motion modification, protection, and indication. The writer discusses gear units used to modify speed to meet specifications. Information is given about devices for protecting motors from abuse, unexpected overloads, and jams caused by the failure of parts. Thermal protectors and slip clutches are also discussed, and consideration is given to position indicators for providing the operator with constant information regarding the exact position of driven members that are out of sight. Included in the illustrations are pictures of a cowl flap actuator in which a series motor and screw jack are used to obtain linear motion, a control for an aircraft screw-jack actuator incorporating a thermal element to control the position, and an aircraft blower unit with a built-in thermal overload protector. *Machine Design*, August, 1944, pages 123–128, 8 illus.; September, 1944, pages 109–112, 6 illus.



The internally cooled center electrode of the Electric Autolite Company's new spark plug is reported to have increased the electrode life by 300 per cent.

Aerodynamics

Some Two-Dimensional Adiabatic Compressible Flow Patterns. Hans Kraft and Charles G. Dibble. This paper presents a number of adiabatic compressible flow patterns which include subsonic and supersonic régimes at the same time. Specifically, the objective of the investigation is to obtain good records of compressible flow when it is undergoing large deflections such as occur in turbine nozzles and buckets. The patterns are analyzed so that the engineer may have a better understanding of the peculiarities of compressible flow. The velocity gradient receives special attention because of its role as originator of both jet separation and shock waves. The patterns are shown in the actual physical plane and also in the hodograph plane where magnitude and direction of the velocity vector are the polar coordinates. The hodograph variables are used because they allow the linearization and exact solution of the differential equations. The method of solution is not new. A large-scale execution of it, however, has not been previously undertaken. The patterns demonstrate effectively the relation between the hodograph and physical planes. *Journal of the Aeronautical Sciences*, October, 1944, pages 283–298, 21 illus.

Prediction of Longitudinal Dynamic Stability. H. P. Liepman. The conventional equations of motion for disturbances from steady level flight are set up and solved in simplified form. The solution of these equations leads to a characteristic stability quartic whose coefficients determine the stability or instability of the motion. The coefficients of the stability quartic are functions of two stability parameters and the absolute angle of attack. The stability parameters can be expressed in terms of basic design and aerodynamic data, taken from an accurate and detailed static stability calculation. Graphs are constructed to facilitate the determination of the stability parameters in terms of wing and tail areas, tail length, mean wing chord, gross weight, moment coefficient slope, tail lift coefficient slope, flight speed, and lift coefficient. A stability criterion is developed, independent of the flight condition, containing geometric design data only and the slopes of the aerodynamic coefficients. This stability criterion is reduced to a single graph, which can also be used to predict stability at any altitude. The period of oscillation is also given in terms of the stability parameters and the angle of attack. The equations and graphs clearly indicate what design changes will make a dynamically unstable airplane stable. Because of the ease and rapidity of the method, it can be included in the routine static stability calculation, thus giving complete information about the stability of an airplane. *Journal of the Aeronautical Sciences*, October, 1944, pages 307–312, 6 illus.

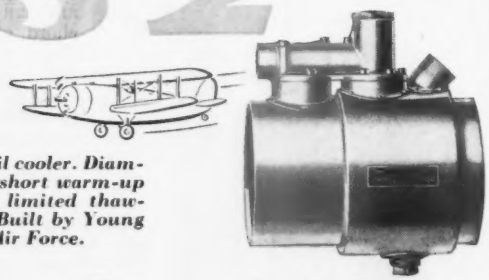
The L.P.C. Method of Performance Computation. Joseph V. Foa and Bernard M. Leadon. Existing methods devised to simplify the tedious classic procedure of performance computation depend either upon generalized parameters or upon approximate curves valid only in a restricted range, with the result that calculations usually are not accurate even in the low-speed range and for high speeds are hardly applicable. Inasmuch as *the force coefficients* (C_L and C_D) become functions of the speed at high speeds, while the object of the performance computation is to determine the speed through a knowledge of these coefficients, the solution of this interlocking problem becomes extremely cumbersome by the usual analytic means.

This paper describes a new method of solution which makes direct use of the actual airplane polars without approximations. The procedure is based on an extension of the Eiffel-Rith coordinate system, and all scales can be incorporated in a simple transparent chart, thereby eliminating the necessity for specially prepared graph paper.

Compressibility effects are taken into account through the use of constant altitude variable Mach Number polars which are derived from constant Mach Number polars of the true airplane. *Journal of the Aeronautical Sciences*, October, 1944, pages 329–338, 13 illus.

Periodic Aerodynamic Forces on Rotors in Forward Flight. Charles Seibel. A new explanation is advanced for the cause of vibrations in rotary wing systems in forward flight, based on the fact that the down-wash is greater in the rear part of the swept disc than in the front part. An estimate of the magnitude of the down-wash variation at different forward speeds is made with the aid of data previously published by the N.A.C.A. on tests of a 10-ft. gyroplane rotor. This nonuniform down-wash causes a peri-

1932



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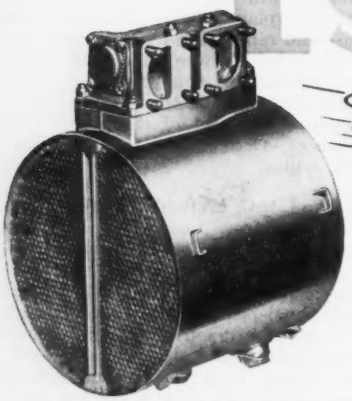

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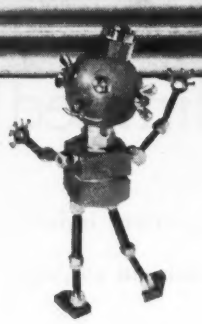
odic change in the drag force on a blade and is a cause of forced vibrations, especially noticeable in two-bladed rotors at low air speeds. *Journal of the Aeronautical Sciences*, October, 1944, pages 339–342, 2 illus.

Contracting Cones Giving Uniform Throat Speeds. Richard H. Smith and Chi-Teh Wang. A difficult problem in fluid mechanics that arises frequently, especially in the design of venturi meters and wind tunnels, is to find the geometric form of contracting cones having uniform flow speeds at the throat. The solution given in this report makes use of the exact analogy between the magnetic field that is created by two coaxial and parallel coils carrying electrical current and the velocity field that is created by two corresponding ring vortices. The high uniformity of the magnetic field over a core area when the coils are suitably arranged is well known. A corresponding uniformity of the velocity field over the same core area is here obtained by simply translating the electromagnetic solution into an aerodynamic one and by choosing one of the stream surfaces as a flow boundary. The geometric form of the stream surfaces is found without difficulty. A family of these contracting cones is developed, the inner eight of which give throat speed distributions that are uniform theoretically within a fifth of 1 per cent. The distributions become less uniform for the outer cones, but variations from uniformity are still less than 1 per cent even for the outermost one. Essentially, the same throat uniformities will occur in the case of real airflows, provided the upstream flow is uniform and the downstream, or diffuser, flow does not separate. *Journal of the Aeronautical Sciences*, October, 1944, pages 356–360, 6 illus.

Aero-Elastic Instability in Unbalanced Lifting Rotor Blades. Reinhardt Rosenberg. Lifting rotor blades, which are unbalanced (tail heavy) about the quarter chord, are subject to flutter. Because of the action of the centrifugal force, additional energies which do not occur in the flutter analysis of fixed wings must be considered when the equations of motion are written. The equations of motion, their solution, and three-dimensional expressions for the elements of the stability determinant are derived. The treatment of the air forces is similar to that given by Smilg and Wasserman as derived from the works of Theodorsen and Küssner. The fact, unfamiliar in classical flutter theory, is developed that the mechanical terms of the determinant elements as well as the aerodynamic terms, are functions of the reduced frequency. In addition a labor-saving two-dimensional approach is indicated. In conclusion, expressions are derived from which the speed of torsional divergence can be determined.

The treatment of the subject is classical; it rests on standard methods in dynamics and is in part based on the



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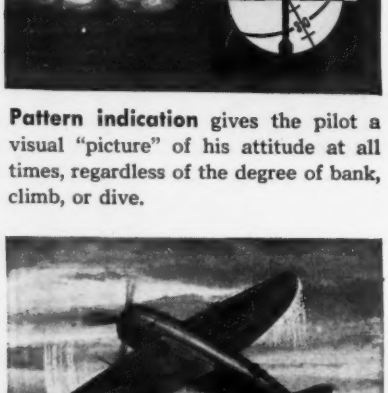

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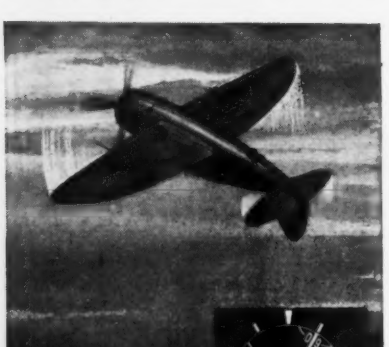

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development of other investigators, most of whom are mentioned in the list of references. *Journal of the Aeronautical Sciences*, October, 1944, pages 361–368, 3 illus.

Drag of Airfoils in Grids of High Solidity. J. R. Weske. Airfoil grids of high solidity are applied in duct bends, in the blading of turbines and compressors, in heat exchangers, and in numerous applications, such as scavenging ports of two-cycle Diesel engines. The present investigation deals with grids of zero stagger, operating at zero lift and consisting of symmetrical airfoils, profile N.A.C.A. 0012. An analysis is undertaken of the drag of airfoils in grid arrangement. It is concluded that:

1. The drag of airfoil in grids of high solidity may be calculated with sufficient approximation from the momentum equation of the turbulent boundary layer, assuming a constant mean value for the coefficient of skin friction.
2. Momentum transfer in the wake n a field of adverse pressure gradient causes losses larger than those encountered in the wake of individual airfoils. This increase of drag is of significance, however, only in the case of grids of large solidity ratio.
3. In grids of high solidity ratio there is evidence of displacement of the flow from the ends of the airfoils toward the midspan portions, observed previously and referred to as jet contraction. This phenomenon, which may be related to transverse contamination of the boundary layer, produces a condition of flow at the ends resembling separation while the flow on midspan still adheres. It is believed to increase the drag of grids of high solidity above values that might be expected on the basis of profile drag alone. *Journal of the Aeronautical Sciences*, October, 1944, pages 369–372, 5 illus.

The Response of Helicopters with Articulated Rotors to Cyclic Blade Pitch Control. A. F. Donovan and M. Goland. Results are obtained which permit calculation of the response of rotary wing aircraft to arbitrary control displacements. The type of craft specifically dealt with is equipped with a single lifting rotor, whose blades are hinged so as to possess freedom in flapping. Control of the craft is effected by cyclically varying the pitch of the rotor blades.

A criterion for the stability of such machines is derived, taking into account seven degrees of freedom. These are (a), (b) longitudinal and transverse motion of the center of gravity of the fuselage; (c), (d) rolling and pitching about the center of gravity of the fuselage; (e) tilt of the rotor cone in a pitching sense relative to the fuselage; (f) tilt of the cone in a rolling sense relative to the fuselage; and (g) coning of the rotor blades.

The suitability of cyclically varying the pitch of the rotor blades to obtain control of the craft is investigated, and the response of the machine to abrupt control displacements is studied in detail.

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

Numerical calculations are carried out for a particular machine in an initial hovering, or near hovering, condition. The present criterion indicates that the single rotor craft (of conventional design) is dynamically unstable; however, the period of the unstable oscillation is found to be almost twice as long, and the rate of amplification very much smaller, than is indicated by the previously published results of Hohenemser. Hence, the present treatment indicates the machine to be less unstable than has heretofore been assumed.

It is found that a condition of neutral stability is attained if the drag forces on the rotor are eliminated.

The response of the machine to an imposed cyclic pitch is traced through the first several seconds of motion, starting from the hovering state. The results are shown in graphic form. *Journal of the Aeronautical Sciences*, October, 1944, pages 387–398, 1 illus.

Takeoff Analysis for Flying Boats and Seaplanes. Part II. Ernest G. Stout. The concluding section of a two-part article gives a treatment of the planning function of seaplanes at take-off. A method is outlined for determining the point of transition from free trim to best trim, and for maintaining best trim with its accompanying lower resistance. Formulas are developed for calculating the water resistance, the aerodynamic drag, the aerodynamic and hydrodynamic resistance, and the thrust available at each increment of velocity. Propeller characteristics are defined under the classifications of activity factor, power factor, power coefficient, thrust coefficient, and advance ratio. The computation for thrust fall-off is explained with the aid of charts and tables; this leads to the determination of acceleration thrust and the take-off time in seconds and distance in feet.

After an explanation of the derivation of a modified method in which the procedure is simplified by computing the wing lift in terms of the hydrodynamic load coefficient, the writer discusses the Hermann Graphical Method, a modification of the classical integration method, using a graphic construction on the thrust and resistance curves rather than the integrated areas. He states that although the method is not so accurate as the standard procedure, it is satisfactory in most cases, being particularly helpful when a planimeter is not available for determining the areas of the time and distance curves. Examples are worked out in detail for determining the take-off time and distance of a hypothetical flying boat. An example of the Hermann Method is also given, and a lengthy explanation is made of allowances to be computed for the effect of wind. Numerous tables and graphs contain data used in the various computations. *Aviation*, September, 1944, pages 132–148, 269–271, 273, 275, 18 illus.

How Much Faster? J. Black. This article deals with the phenomenon of compressibility, which, it is noted, is a serious obstacle to increasing the speed of airplanes. The writer discusses the meaning of compressibility, conditions that arise when the speed of sound is reached, and the compressibility error. Other sections deal with the effect of compressibility on the lift and drag of the wing, new airfoil sections, shock waves, and boundary-layer control.

Assuming that no totally different method of obtaining lift will be discovered, it is predicted that wing airfoil sections of the future will be of completely new profile. They will be thin and have sharp leading edges, and their points of maximum thickness will be located up to 50 per cent of the chord back from the leading edge. Both surfaces will be convex. Because of the thinness of the wing section it may be necessary to return to external bracing or to the adoption of a biplane arrangement. Some form of boundary-layer control will be applied to the wing surfaces. *Aeronautics*, September, 1944, pages 34–37, 7 illus.

General Approach to the Study of Forces on an Airfoil. Raoul J. Fajardo. Because of the confusion often arising from the variety of methods of aerodynamic analysis, sometimes extending even to fundamental matters, the writer undertakes to analyze the phenomena of the creation of lift from a purely physical point of view. He begins by giving a generalized definition of two fundamental types of flow—two- and three-dimensional. These are explained, and there is information about how lift is created and about the relationship of Newton's law, Bernoulli's theorem, and Lancaster's assumption. Lift drag, form drag, and profile drag and their effects are defined, as is the spanwise component of flow. Mathematical expressions are derived for the calculations of these forces and for the computation of a change in the span.

The effect of down-wash is considered, and corrections are introduced for drag and angle of attack. An explanation is given for the difference between physical and mathematical two-dimensional flow. The writer indicates how tip vortices are created and how to deal with effects of the forces they exert. An expression is given for the total drag of a wing in

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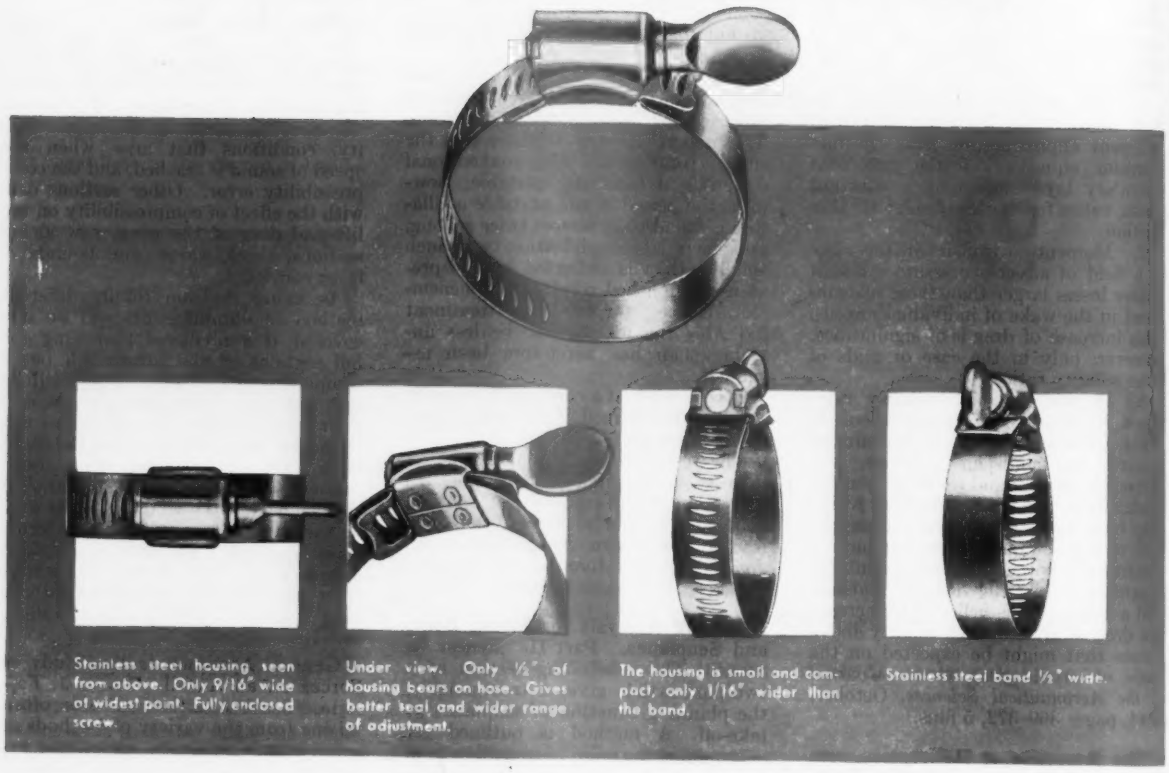
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three-dimensional flow, and Schrenk's basic assumption concerning the actual lift distribution is restated. The basic functional concepts of the action of a wing are summarized. *Aero Digest*, September 1, 1944, pages 99, 100, 122, 124, 126, 2 illus.

Rigorous Solutions for the Spanwise Lift Distribution of a Certain Class of Airfoils. Otto Laporte. The point of view used by Trefftz in a solution for the spanwise lift distribution is extended, but instead of "seeking an approximate fulfillment of the boundary condition" for an arbitrary chord function, $c(y)$, a simultaneous choice of the function and of a conformal mapping function transforms the problem into a boundary value problem of classical type, which can be solved rigorously and in every detail. The resulting formulas lend themselves readily to numerical computation. *Quarterly of Applied Mathematics*, October, 1944, pages 232–250, 8 illus.

Momentum and Speed in Flight. Lt. (j.g.) Paul R. Shipps. A consideration of momentum as a factor in flight. The effects of inertia upon attempted changes in the speed of an aircraft are investigated. The discussion extends to an examination of the momentum effect under varying wind velocities, in the case of the helicopter, in instrument flying, and in formation flying. *Air Facts*, October, 1944, pages 60–62, 64–66.

Aerodynamic Features of German Aircraft. M. B. Morgan and R. Smelt. This article comprises the text of a lecture delivered by the writers at a meeting of The Royal Aeronautical Society on March 9, 1944. A detailed analysis is made of the structural features of the Me 109, Me 110, FW 190, Heinkel 111, and Ju 88. The handling characteristics of each of these aircraft are examined. A brief history of the development of the aircraft is given and general design features are outlined. Aerodynamic data are presented in tables. The performance characteristics are set forth and detailed information is given about the handling qualities of each of the aircraft.

A survey is made of the aerodynamic features of various engine-cooling arrangements employed. The provisions for clearness of vision from the aircraft are studied. The method of lightening the ailerons by swinging weights in the wing tips, as used on the Ju 88, is described in an appendix. *The Journal of the Royal Aeronautical Society*, August, 1944, pages 271–331, 56 illus.

Air Cargo

Shippers' Right to Route Air Cargo. John H. Frederick. It is noted that under present conditions shippers and receivers have no right or power to route air express or to select the air line that may carry their shipments any more than they have the power to route rail express. Whether shippers or receivers will ever demand the right to route or to designate the air line that will carry their air express or air cargo is stated to depend on (1) whether the air lines compete openly for plane-load and less-plane-load cargo in the future, and (2) whether air cargo transportation develops as complicated tariffs, differential routes, and rates, combination rates, intransit, and other special services that have made routing important in rail transportation.

To aid in explaining what may be involved in this routing question from the shippers' point of view, the writer describes what routing is as it has been developed in railroad transportation, examines the various reasons why shippers route one way and another, and considers whether this right of routing will be as important to shippers of air cargo in the future as it has been to rail shippers. It is concluded that shippers and receivers ought to have as many routing powers over air cargo as fit the circumstances involved in this type of transportation. *Distribution and Warehousing* (*D and W*), September, 1944, pages 37, 38, 83, 84, 86.

Air Power

Air-Warfare Review. Gill Robb Wilson. Some general remarks about the role played by American air power in the successful conduct of the war. The record of American aircraft and their utilization is lauded. The employment of air forces as a lever for ground-force mobility is also discussed, and a few predictions are made with regard to the future military use of aviation. The possibilities are advanced that, in a standing peacetime army, infantry and field artillery will be 100 per cent airborne and that the Marine Corps will be oriented gradually into an amphibious air corps. *Skyways*, October, 1944, page 19.

Airpower Can Mean National Security. J. Carlton Ward, Jr. Stressing the fact that the future security of the United States is dependent upon a program of continued research and development for maintaining air supremacy, the President of Fairchild Engine & Airplane Corporation recommends several points as the basis for such a program. He reviews the effects of the air-power policies followed by France, Germany, and the United States prior to World War II and indicates lessons that are to be learned from the experience of each. In the case of America, he shows that almost all of the air-combat equipment now in action had its origin in the prewar period. It is his opinion that a nation cannot have time to arm in the air when confronted with a major international crisis but must maintain its air superiority through support of continuous research and development.

The specific program outlined by Mr. Ward advocates the following: (1) Present development contracts should be terminated. (2) Military research, design, and development should be continued on a constructive basis through competitive private industry. (3) A production program for the aircraft industry should be maintained to retain its ability to establish production processes and to permit the air forces to become familiar with the handling of such planes. This would assume that 20 per cent of the number of airplanes in the air forces will be replaced annually. Knowing the size of the postwar air force would give the industry a basis for planning. (4) New and advanced models of all types of military aircraft required for a balanced air force should be developed, and quality of the product should be the primary factor in placing orders. *Aviation*, September, 1944, pages 108, 109, 251–253, 2 illus.

"Air Effect." Air Com. A. W. F. Glenny. Stating that the full results of air action cannot always be judged by the direct effects that it achieves, the writer reviews the value of air attack in land warfare. After briefly noting the role played by air power in preparing for the Allied invasion of Western Europe and in protecting the landing of the ground forces, he discusses tactical air operations subsequent to the landings. These activities are examined under three general classifications: (1) battlefield "deluge" bombing by heavy bombers; (2) isolation of the battlefield through destruction of the enemy's radar stations, gun emplacements, and fixed defense; and (3) harassing air action and close offensive support on, and close to, the battlefield. *The Aeroplane*, August 4, 1944, pages 134, 135.

The Future of Air Power. Capt. Norman Macmillan. The subject of air power is discussed with particular regard to Britain's position after the war. Geographical, political, and financial problems affecting the future of air power are examined. It is stated that new rules will probably be required for international airdromes. A map shows the principal distribution of world sovereignty in relation to air power. *Aeronautics*, September, 1944, pages 24–28, 1 illus.

Where is the Luftwaffe? Alexander Kiralfy. A theory is advanced about the failure of the German air force to show itself in great strength and its refusal to fight decisive battles in western Europe. The writer claims that Allied air assaults upon the Luftwaffe and its production centers have reduced the Luftwaffe to an inferior air force, compelling it to adopt the tactics and dispositions of inferiority. He explains the pecularities and strategies of inferior air power and concludes that, since it is now simply a supporting arm for the German armies, the Luftwaffe will fall when those armies are crushed. The writer also refutes three alternative theories that have been offered in explanation of the German air force's "absence." One is that the Luftwaffe is so reduced in numbers that it must shun action; another that

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the Germans are reserving their aerial strength for an all-out blow at the proper time; and the third, that it is preparing unknown weapons or tactics. *Flying Aces*, October, 1944, pages 10–12, 55–57, 4 illus.

Luftwaffe: 1939–1944. In a brief outline history the tactical decline of the German air force is traced. Mistakes made by the Germans in the use of air power are analyzed, and the article records how the Luftwaffe degenerated from a powerful air force to, first, a defensive weapon; then, a night-fighting weapon; and, finally, an aerial police force for the German home front. The reason given for the current inferior utilization of the Luftwaffe is that the German air force is being saved to defend the Nazis against those Germans who oppose the Nazi régime. *National Aeronautics*, September, 1944, pages 11, 12, 68, 2 illus.

Air Transport

We Run a Feeder Line. Keith Kahle. An operator reports on his experiences in conducting a feeder-line air service. Telling of the opposition that "independent" companies meet in the field of air transport, he indicates the commercial and civil importance of the feeder lines. In addition to presenting data about the services that Central Airlines renders, its equipment, operating expenses, methods of advertising, and policies of courtesy, he also discusses general questions concerning flight equipment for feeder air lines, the possibility of having Government-owned airplanes converted for feeder-line use, and route patterns for such type of service. The writer expresses the opinion that people going to smaller cities and towns do not demand twin-engined airplanes in which to travel. *National Aeronautics*, September, 1944, pages 16–18, 2 illus.

The Coming Railroad-Airlines Battle. Part I. Swanee Taylor. Part I of a criticism of the railroads in their attempt to enter the air transportation field. The political strategy that will probably be followed by the railroads to have their "Integration of Carriers'" plan accepted by the nation is predicted. Extensive lobbying, endeavors to have the proposed Air Commerce Act rewritten with a provision allowing the rail carriers to engage in air transportation, a proposed Uniform State Air Commerce regulatory bill prepared by the National Association of Railroad and Utilities Commissioners, the U.S. Chamber of Commerce's endorsement of the Integration of Carriers' plan, and extensive advertising by the railroads are among the activities forecast and discussed. This introductory article also calls attention to abuses and disregard of the public welfare which, it is claimed, have formed part of the railroads' earlier history. *Southern Flight*, September, 1944, pages 33–35, 1 illus.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

Reconversion of Army Planes. Part II. J. A. Butcher and R. E. Franz. The concluding one of two articles investigating the engineering problems of air lines in converting aircraft from specifications for military service to those that will fit them for civil air transport. Discussion in these articles is restricted to the particular phases of conversion projects which may be considered engineering functions and directly chargeable to engineering. Part I was concerned with consideration of conversion-costs problems and of the engineering department's responsibility in directing and carrying out a conversion project. In Part II actual conversion procedures and methods adopted by Northwest Airlines are reviewed. The stages of preparation and work outlined include the obtaining of preliminary information indicating the design, equipment and condition of the plane when it will be turned over to the air line; the establishment of routine conferences for the clearing of information among the various departments; inspection of the airplane before it is delivered to the overhaul base; the listing of projects under two separate classifications (one including those projects necessary to bring the plane up to the air-line standards of June 1, 1942, and the other for present-day standards); liason arrangements with the manufacturer; issuance of project information and details; recording the job progress; rework of old projects; project assignments; and the licensing of the converted airplane.

As a result of Northwest's experience in completing conversion jobs, certain problems are noted which are believed to require thought and action by the air lines as a group and also by the individual air lines. Subjects recommended for consideration by the air lines as a group are assignment of aircraft, purchase costs, C.A.A. acceptance, and basic information available. *Aero Digest*, September 15, 1944, pages 96, 97, 149, 150, 152, 4 illus.

Confusion in Canada. Keith Edgar. Canada's air transport system is criticized as being under the control of one man—the Minister of Munitions and Supply. Claiming that the "government-owned" Trans-Canada Air Lines has a virtual monopoly of air transportation, the writer expresses his fears with regard to the future of air transportation in Canada if free enterprise is not the motivating power behind its development. He takes the experience of Canadian Pacific Airways in showing that under the present system, after privately owned air lines pioneer and promote transport service over areas of Canada, the routes can be taken over by Trans-Canada Air Lines as soon as they are considered "mainline" in character. Determination of their "mainline" status and issuance of air transport licenses is subject to the approval of the Minister of Munitions and Supply. *Aviation*, September, 1944, pages 168–170, 256, 257, 259, 4 illus.

Airplane Descriptions

Avro York. Construction and design details of the Avro York, civil transport airplane, are reviewed. Although the wings, engine nacelles, undercarriage, and tail plane fins and rudders are standard components of the Lancaster, bomber-version original of the York, features that differentiate the York are noted in the entirely new fuselage; the setting of the wing, and the addition of a central tail fin. Attention is also called to the arrangement of the crew quarters, the instrument panel, and the control equipment. Essential information about the airplane is listed in tabular form. *Flight*, August 17, 1944, pages 176–180, 12 illus.; "The Avro York Passenger Liner," *The Aeroplane*, August 18, 1944, pages 181–185, 8 illus.

Aeroplanes of the Turkish Air Force. A brief review is given of the history of the Turkish air force from the termination of the first World War to the present. The important part taken by the Turkish Air League in building up a group of trained airmen and in opening the first aircraft factory in Turkey in 1927 is discussed. The factory was a branch of the German firm of Junkers, but it was closed in 1928 and later reopened as a government enterprise that built American, German, and Polish airplanes under license. A private company was formed in 1937 and their products are briefly described. Specifications of the nation's present military aircraft are given. *The Aeroplane Spotter*, September 7, 1944, page 208, 9 illus.

Cross-Country Culver. Victor Boesen. A description of the prewar Culver model and an outline history of the company supplement, some data on the Culver airplane that will be manufactured for postwar use. Among the plans that are projected for the new model are longer range, two-way radio, more roominess and comfort in the cockpit, tricycle-type landing gear, plywood construction, and wings built on the stressed-skin principle. *Skyways*, October, 1944, pages 28, 29, 78, 104, 5 illus.

Two German Aircraft Innovations. Some brief notes pertain to two new

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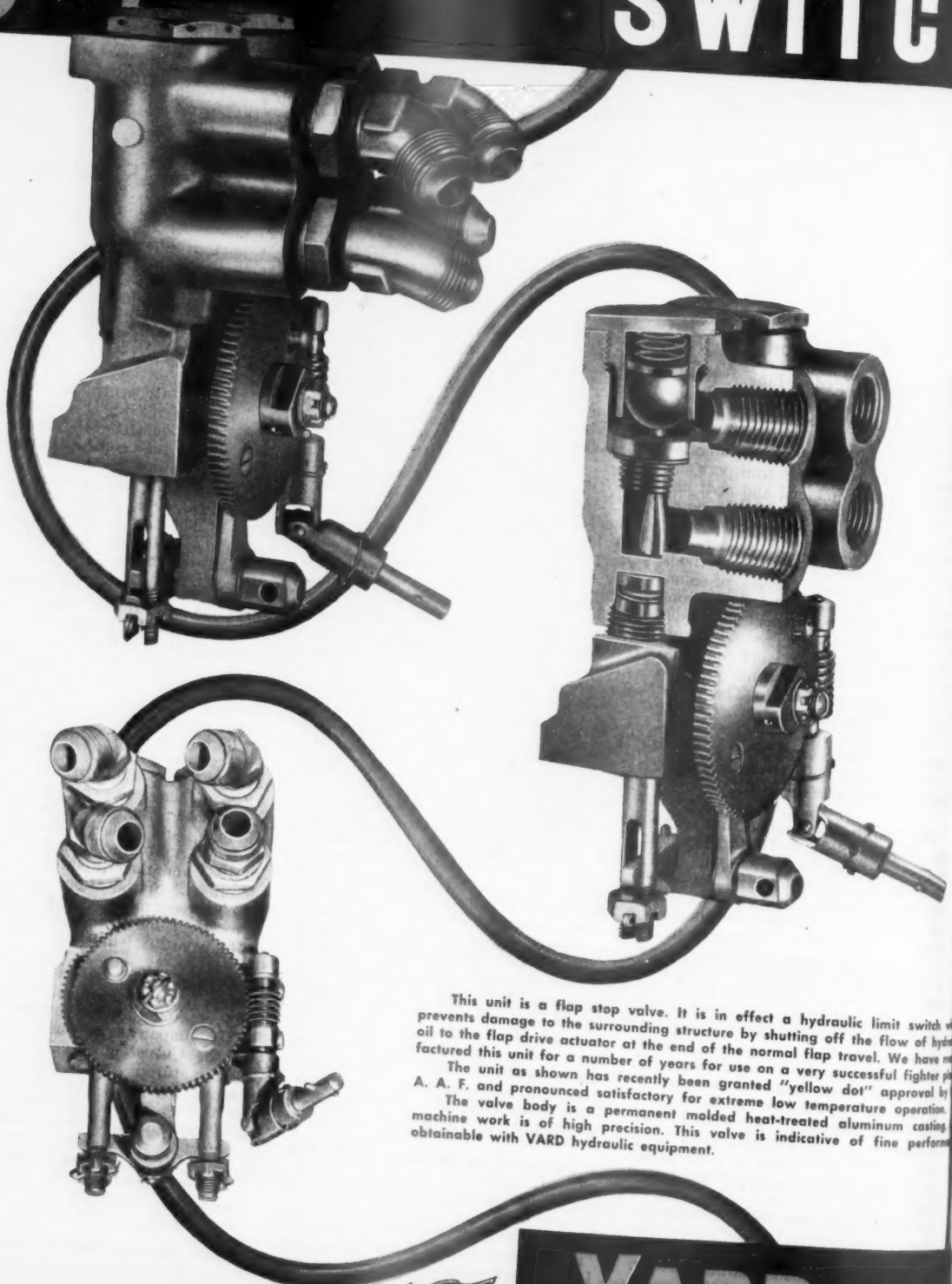

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developments in German operational aircraft, the rocket-assisted Me 163 fighter and the Me 109/Ju 88 combination. The Me 163 is reported to be the first encountered instance of the rocket-assistance principle being applied to an enemy fighter. The assistance is employed to give an extra burst of speed over brief intervals in order to avoid combat.

In the Me 109/Ju 88 composite aircraft, a Ju 88 is converted into a flying bomb with an Me 109 attached to control it during the take-off and to direct it toward its ultimate target. With its armament removed, the forward section of the Ju 88's fuselage is filled with explosive. The engine and flying controls of both components are operated by the pilot of the Me 109 (the upper component) who can set the Ju 88 component on a predetermined course before separation. It is believed that, after separation, the Ju 88 remains under the radio control of the Me 109 pilot who operates it from a supposedly "safe" distance. *Flight*, August 10, 1944, page 150.

Grumman J4F-2 "Widgeon." Design details are given about the Grumman Widgeon. Used for coastal patrol and rescue work by the Coast Guard and Navy, as a personnel transport, and as a trainer for instruction in instrument flying, the J4F-2 is described as a four- to five-place, all-metal, high-wing amphibian monoplane. It is powered by two six-cylinder Ranger inverted in-line engines rated at 200 hp. each at 2,450 r.p.m. for sea-level operation. The hull is of semimonocoque construction and forms an integral piece with other components. Watertight wells are built into the hull for the retraction of the main landing gear and tail wheel.

Schematic drawings illustrate the design information. These include sectional views of the engine and accessories, hydraulic system, main landing gear, hull structure, aileron controls, rib structures, and outer-wing panels. *Aero Digest*, September 15, 1944, pages 98–102, 11 illus.

Constellation. A description is given of the features of the C-69 Lockheed Constellation transport, which is now in production for the Army Air Forces. The article gives particular attention to the features of the airplane, indicating that it will probably be used extensively in postwar civilian transport because of its pay-load carrying ability and operational economy. Some performance figures are given and important specifications of the plane are listed. *Weight Engineering*, Fall, 1944, pages 5, 40, 49, 3 illus.

Airports and Airfields

Airport Underground Cable. Donald D. Clark. A method used to locate exact positions of trouble in underground high-voltage airport field-lighting cables is described. The method has been used in "shooting" trouble in the field-lighting system of the Kern County Airport. It involves the use of a portable radio and an automobile. *Aviation Maintenance*, September, 1944, pages 72, 127, 128, 130, 3 illus.

How States Would Share Airport Millions. An interpretation of the formula for state allocation of airport funds contained in Congressman Jennings Randolph's proposed bill, HR 5024. The bill provides for a billion-dollar civil airport construction program, with funds apportioned to each state according to this formula. The formula is based on ratios of population, certified aircraft, land and water areas, and existing airports. Estimated amounts that will be allotted to each state under such a plan are listed. *Southern Flight*, September, 1944, page 53.

Steel-Paved Steps to Tokyo. H. W. Richardson. An account of how contractors, Navy construction battalions, and Army engineer troops are building a series of airports along the northern road to Tokyo, which follows the 2,000-mile sweeping curve of the Alaska Peninsula and the Aleutian Islands. It is noted that these aerial stepping stones to Japan are steel-paved and surfaced with steel plant mat. The writer tells how problems of runway construction were solved. It is stated that at Adak the field was built in a tidal swamp closed off from the sea by a sand dike, and at Amchitka the strip was built during enemy bombing. *Engineering News-Record*, September 21, 1944, pages 78–82, 6 illus.

Airports for the West. Part III. Third article in a series investigating the requirements for postwar airport facilities in the Western part of the United States and discussing some of the problems involved in the establishment of those facilities. Part III discusses the importance of providing for future expansion in the planning of an airport. Illustrated by diagrams, the evolution of a hypothetical western airport as visualized by the Airports Service of the C.A.A. Sixth Region is traced. Six progressive steps are shown by which a small city may take care of its immediate airport needs and at the same time make provision for its possible future requirements as a major airline division point and industrial center. *Western Flying*, September, 1944, pages 56, 58, 6 illus.

Making the Airport a Business Center. Melvin H. Nuss. A program is outlined for making an airport an integral part of a community's business activity rather than just a passing point through which passengers come and go. Plans for the postwar expansion of the airport at Reading, Pa., include provision for air-line offices and maintenance shops, comfortable accommodations for passengers, separate spaces for sightseers, stores, adequate parking space, a bus terminal, banking facilities, and possibly a theater. Arrangements are being made also for a produce market to form part of the general airport layout. *Aviation*, September, 1944, pages 112, 113, 4 illus.

Revenue vs. Costs at Love Field. Through a series of tables the revenues and costs of running Love Field, Dallas, Tex., are summarized. The tables show the 1944–1945 budget, the 1944–1945 estimate of income, and the list of charges upon which the revenue estimates are based. *Southern Flight*, September, 1944, page 52.

The Saga of the Greenland Bases. A description is given of how American contractors and U.S. Army engineer troops constructed bases and airports in Greenland for the protection of sea lanes and the east coast of North America. In addition to comments about the severity of the weather conditions and the difficulties under which the work was carried on, the article gives many of the details of the engineering features of the construction and operations. *Engineering News-Record*, September 7, 1944, pages 96–100, 10 illus.

Mobile Tower. E. M. Hockensmith. A description is furnished of a mobile airport traffic-control tower that is mounted on a truck chassis. It is painted in a checkered pattern so that it can easily be seen by pilots. It is explained that it has been developed to meet the need for a portable control tower that could be used either on new airfields before the erection of a permanent tower or on established airfields when the regular tower has been disabled by the enemy or destroyed by some accident of nature. The unit is prepared for emergency operation under its own power, having an independent electric plant, complete radio equipment, traffic-control lights and signals, station altimeters, and other apparatus. *Air Trails*, November, 1944, pages 33, 64, 1 illus.

A Trick with a Tee. Walt Bohrer. An airport wind tee is described which can be remotely operated from the control tower. Devised for use by the Rankin Aeronautical Academy, the gear reduction mechanism for the tee was made from old car parts, second-hand aircraft tubing, used tin, and a 1/6-hp. electric motor. Photographs of the remote-control unit are shown. *Western Flying*, September, 1944, pages 78, 168, 4 illus.

Long Span Laminated Timber Arches for an Aircraft Hangar. Alfred Zweig. Particulars are given about the construction of an aircraft hangar at Hagerstown, Md., which is of interest because of the long-span arch ribs employed, the procedure followed in designing the arches, and the method employed to accommodate

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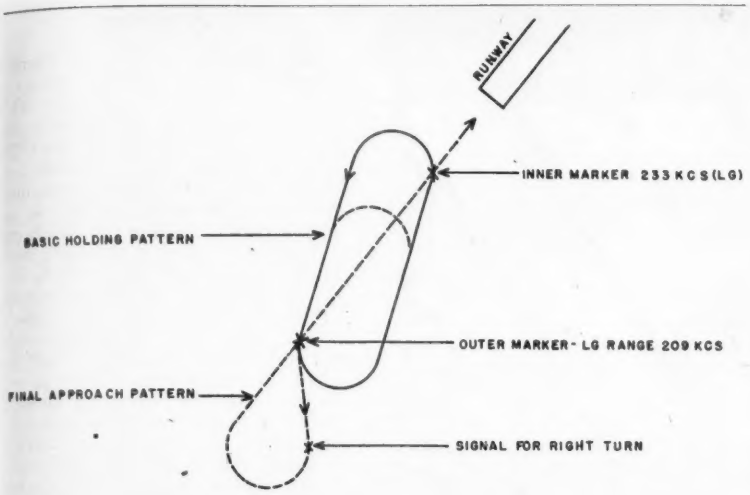

Conceived by a captain of American Airlines, a new method is expected to direct transport airplanes to landings at a rate of 20 or better per hour under instrument operating conditions. Positive altitude separation serves as the basic method of separating flights in the new plan. Two radio markers used in conjunction with direction-finding equipment on the airplane confine the holding pattern to a small and efficient area. Spacing of flights on the final approach path is accomplished by means of simple instructions to the pilot and is carried on without disturbing the basic altitude separation between flights. The illustration shows the approach control for La Guardia airport.

wind loads on the ends of the structure. Three-hinged laminated arch ribs of $7^1/_2$ by 36 in. cross section and 171-ft. span serve as the principal framing. A horizontal overhead truss that spans the full length of the hangar at the front end accommodates the wind loads at both ends of the structure. *Engineering News-Record*, September 21, 1944, pages 83–85, 4 illus.

Sweden's New World Airport. Some brief information is given about a proposed new airport to be built in the outskirts of Stockholm. Drawings from the Swedish magazine *Flyg* illustrate the tentative layout of runways and buildings. A feature of the plan is the location of the hangars at one side of the airport, away from the runways and passenger-loading areas. It is reported that the new airport would probably be the terminus for the newly organized international Swedish air line Svensk Interkontinental Lufttrafik A.B. *Aero Digest*, September 1, 1944, page 60, 3 illus.

Air Conditioning Airport Control Towers. G. V. Bond. The air conditioning and refrigeration of control towers is discussed. It is noted that in these glass-enclosed observation posts, which are exposed to the sun and must be kept closed to keep dust from sensitive instruments, the operators cannot work efficiently without humidity and temperature control. Because control towers for commercial airfields vary in layout, air conditioning engineers are presented with different individual problems. The Army and Navy, however, have standard designs, the features of which are outlined. The air conditioning of commercial air-line control towers is discussed in some detail. *Heating and Ventilating*, September, 1944, pages 53–55, 3 illus.

Mobile Units in the Fueling and Servicing of Plane. A. F. Meyer. A description of two mobile units for fueling aircraft is supplemented by a consideration of the advantages offered by mobile units over stationary fueling equipment. The two discussed units are the F-2 and F-3 types built by the Heil Company. Among the limitations of the stationary fueling methods which the mobile equipment is credited with overcoming are the loss of time and money in taxiing planes to the exact fueling location; the loss of time and money in turning planes when opposite wing tanks have to be loaded; and the high costs of installing overhead or pit-type facilities. Fuel-truck capacities are claimed to be adequate for supplying commercial airplanes of the postwar future.

Several improvements that are contemplated for mobile refueling equipment are also listed. These include better means of access to fuel tanks, superior facilities for adding oil to engines, increased lighting facilities for night operation, and greater tank capacity. *Aero Digest*, September 1, 1944, pages 92–94, 130, 5 illus.; "Postwar Aircraft Fueling and Oil Servicing Facilities," by G. J. Herman, *Aero Digest*, September 15, 1944, pages 122, 123, 154, 156, 5 illus.

State Legislation Needs for Airports. John H. Frederick. The writer's opinion of whether aviation should be regulated by State or Federal laws is that there should be a compromise between the two. He believes that there are phases of aeronautical legislation which are within the province of the State, while others must come under the jurisdiction of the Federal government. Legislation in connection with airport development, zoning, and control of the air space is advocated as a logical State function; he considers general laws, regulatory in nature, the concern of the Federal government. In connection with an airport program, he discusses the need for State legislation relative to airport acquisition; condemnation of property; lease of municipally owned airports and facilities; use of airports; air space rights of aviators, airport owners, and land owners; and protection of airport approaches by airport zoning.

Three points are made in summarizing the goals toward which State aeronautical legislation should be directed: (1) Legislative and administrative procedures should be uniform. (2) Uniform municipal and state airport regulations and practices should be set up. (3) State laws and municipal ordinances should be coordinated with Federal laws, and duplication of functions should be at a minimum. *Southern Flight*, September, 1944, pages 50, 51, 78, 86.

How to Mark Runways. Phillips Moore. An outline is given of the A.N.C. system of marking and numbering airport runways. *Aviation Maintenance*, September, 1944, pages 54, 55, 160, 162, 7 illus.

Seven Hangars with Modern Equipment in Rigid-Frame Concrete Structure. Howard J. Snitoff. An account is given of how savings in time, material, and labor were accomplished by the selection of a continuous, rigid-frame type of concrete structure for a flight hangar at Buffalo. The writer describes the unusual falsework that was used in the construction of the reinforced continuous beams supporting the prefabricated-joist and precast-slab roof. Information is supplied about the hangar doors, which are of the overhead canopy type; the duct system of electrical feeder circuits, which saved copper; and the mercury-vapor and incandescent fixtures for illumination. The steam-heating units, the sprinkler system, and the independent water-supply system are also described. *Engineering News-Record*, September 7, 1944, pages 116–120, 6 illus.

Armament

The Mark XIV Bombsight. As released by the British Air Ministry, information is given about the construction and operation of the Mark XIV bombsight. The bombsight is described as consisting of a sighting head, which looks like a large microscope, and a computer box, resembling a glass case about the size of a portable phonograph. It is mounted in the nose of the bomber. Photographs of the bombsight accompany the brief descriptive data. *Canadian Aviation*, September, 1944, pages 112, 114, 4 illus.; "Unique Mark XIV Bombsight," *Commercial Aviation*, September, 1944, pages 91, 92, 7 illus.

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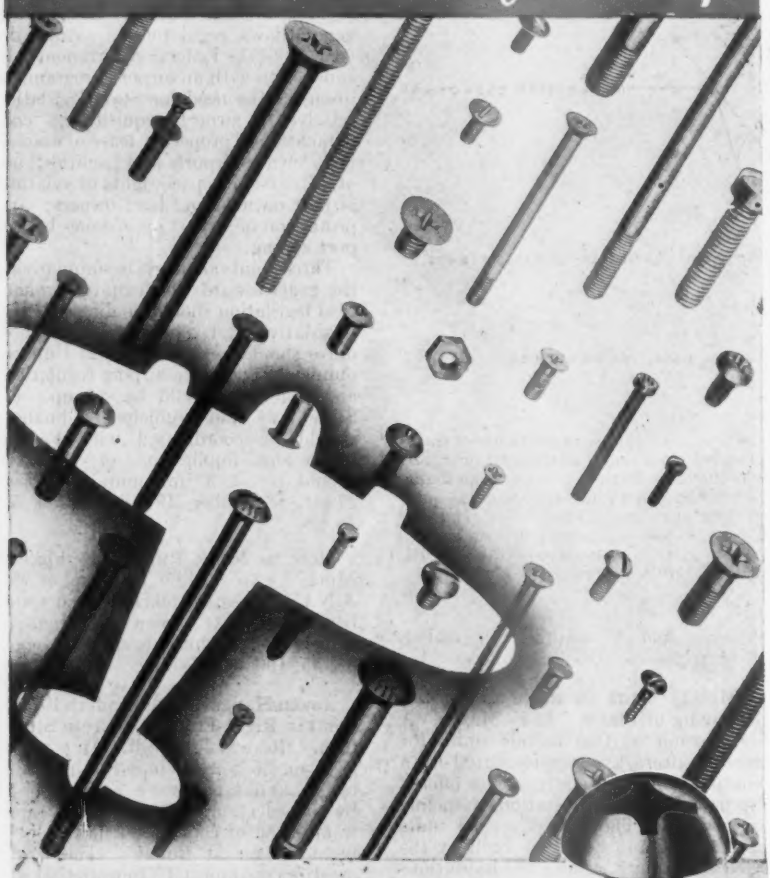

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The instrument is reported to consist of a globe on which are engraved a certain number of stars; date circle, comprising a right ascension scale graduated in days and months, to which the globe is fixed and oriented with the vernal equinox; fixed sidereal-hours circle; pivoting table, representing the celestial equator and comprising a latitude scale and control, to which the sidereal-hours scale is fixed and about which the globe and date circle rotate; inner altitude ring graduated in degrees rotating into the date circle; and a sighting telescope with a setting-pointer parallel to the sighting line sliding into the altitude circle. *Aviation*, September, 1944, pages 173, 242–244, 1 illus.

Business and Finance

Clue to the Course of Air Carrier Stocks. Raymond L. Hoadley. After briefly reviewing the recent course of rises and declines in air-line securities, the writer indicates the trends he believes they will follow in the immediate future and during the war-to-peace conversion period. It is his opinion that, because of adjustments in operating costs and the steady return of planes from the Army, profits in the air carrier industry will probably continue close to their wartime peaks until after the European war is over, with stock market values governed accordingly. For the transition period, however, he predicts smaller earning power for air lines. Offsetting this, he states, will be the favorable market factor of unusual growth possibilities. *Aviation*, September, 1944, pages 188, 275, 277, 2 illus.

Camouflage

Camouflage Models. A description is given of the panoramic terrain model at the Army Air Forces Tactical Center, Orlando, Fla., which is used to familiarize flying personnel with the effect of camouflage as viewed from the air. Built to scale, the model depicts a hub of military activity transformed into an innocent-appear-

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ing countryside and town through the clever use of camouflage. *Air Trails*, November, 1944, pages 30, 31, 6 illus.

Civil Aviation

The Michigan Plan. Sheldon B. Steers. The writer explains why and how Michigan's airport-building program came into being. Indicating the benefits that the State has derived from this program, he tells of its progress in providing "an airport for every community," auxiliary emergency landing fields, "state airways," and "sky camps." The policies followed by the State in this airport-construction program are outlined. Conflicts in certain cases between the recommendations of Federal and State authorities regarding the type of airport required in Michigan communities are noted. Michigan's successful experience is also reported in levying an aviation-gasoline tax on fuel consumed in aircraft for the purpose of establishing flying facilities and fostering aeronautical progress. For the future it is predicted that the majority of local airport requirements will be for Class I and II type airports rather than those designed to accommodate larger aircraft. *National Aeronautics*, September, 1944, pages 13–15, 2 illus.

The Flying Newsroom. Gardner Cowles, Jr. The utility of the airplane for newspaper work is indicated by an account of the experiences of the Des Moines *Register & Tribune* in operating an airplane for news-gathering purposes. The story tells of the different types of airplanes which were used successively by the newspaper over a 14-year period and of how these airplanes helped to make news as well as discover it. As learned from the 14 years of operation, some of the uses and limitations of the airplane in newspaper work are outlined. Of the uses, the one cited as the most important is the pictorial coverage of large, spectacular events that can best be seen and most quickly covered from the air. Another use is the speedy transportation of reporters and photographers who will work on the ground. Possibilities of extending the utility of the airplane for newspaper work in the future are noted in the development of the helicopter. *National Aeronautics*, September, 1944, pages 21, 22, 24, 3 illus.

Control Equipment

Designing the Hydraulic System of a Single Engined Single Place Combat Airplane. J. Jerome and E. Kanarik. This article discusses in considerable detail the problems involved in the designing of a hydraulic system for a single-engined, single-place combat plane. The system was for the operation of landing gear, wheel brakes, wing flaps, and bomb doors. The requirements called for the use of standard and commercially available parts wherever possible and the application of known and proved principles to expedite design and construction. Circuit calculations are given. Sections of the article are devoted to a discussion of circuits for the landing gear, wheel brakes, wing flaps, and bomb doors. The testing of the hydraulic system is described. *Automotive and Aviation Industries*, September 15, 1944, pages 20–23, 66, 68, 70, 7 illus.

Design

Engine Mountings. Maurice F. Allward. Second article in a series discussing the features of engine-mounting design and surveying various types of engine mountings used for military aircraft. Part II is devoted to an examination of a number of mountings for in-line engines. Engine-mounting characteristics that are reviewed include those of the German Me 109 and 110, Ju 87 and 88, and He 111; British Hurricane, Typhoon, and Mosquito; and American Airacobra and Mustang. *Flight*, August 3, 1944, pages 120–122, 10 illus.

The "Catalina" PBY5A Flying Boat. Part II. Concluding half of a design study that analyzes the characteristics of the Catalina flying boat. Part II is concerned with details of the nose, bulkhead, and tail assemblies; control and stability features; landing gear; and anchor, towing, and handling equipment. It also contains notes pertaining to the living facilities in the Catalina and the equipment for changing propellers while afloat. Schematic drawings illustrate the discussed components and accessories. *Aero Digest*, September 1, 1944, pages 86–90, 10 illus.

The Ellipse as Applied to Aircraft. V. R. Billings. It is noted that every new design of airplane presents additional difficulties for the drawing office. One problem is the establishment of the shape of the airplane. Until recently, most designers have been content to have the complex curves of the aircraft shape made by hand. Large manufacturers now establish a mold loft to make a full-size drawing of the aircraft and from this drawing to establish the shape of all parts. The mold loft must be equipped on fairly elaborate lines and involves an outlay beyond the resources of some British aircraft companies.

The writer outlines a method that is intended to achieve the same object as full-size lofting at only a fraction of the cost in space and equipment. It is stated that the method should produce equal or greater accuracy in the results, together with genuinely smooth curves. An outline is shown of a hypothetical airplane in which the opportunities for using elliptical arcs are indicated by heavy lines. A method of establishing equations for such ellipses is included. *Aircraft Engineering*, August, 1944, pages 225–227, 6 illus.

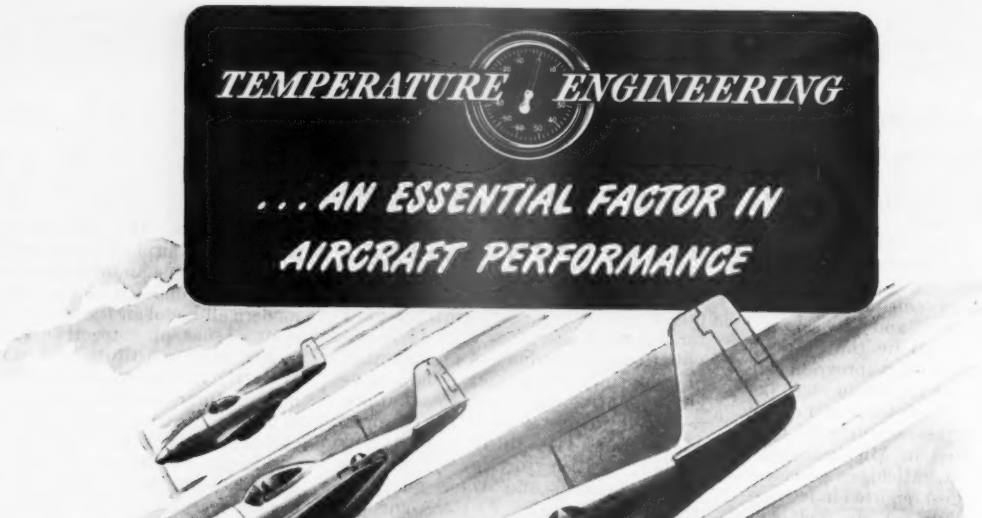
Rational Design of Fastenings. E. S. Jenkins. In this article on the design of airplane joints and fastenings the writer analyzes the behavior of both continuous connections, such as cement joints, and discontinuous connections, such as riveted and spot-welded joints. It is pointed out that the design of airplane joints and fastenings has become an important problem, since about one-half of the cost of the modern all-metal air frame is made up of costs of fastening together the many pieces that constitute the structure. When the metal airplane was developed, manufacturers resorted to new methods of fastening, such as rivets, spot welding, and various types of removable fasteners, in place of the bolts, screws, and glue of earlier days. Later, cementing became feasible, even for metal fabrication, with the aid of the new resin adhesives. *SAE Journal*, September, 1944, pages 421–429 (Transactions), 15 illus.

Orthographic Sketching. Harold R. Bojens. Information is given about the methods used in making orthographic sketches of aircraft components. It is noted that orthographic drawing is a useful tool in developing basic three-view outline sketches of the entire airplane from preliminary design data, in preplanning large orthographic layouts or production drawings, as a guide to fabrication of parts in experimental and mock-up departments, and in the interpretation of complicated assembly and installation drawings. *Weight Engineering*, Fall, 1944, pages 24, 25, 47, 48, 13 illus.

Annular or Tandem? Features of an annular fighter-design project are investigated and illustrated. The Peel design calls for wings that form a ring with the elevators, although not a circular one. It was developed from the basic considerations of using two engines running in opposite directions so as to eliminate torque reaction and at the same time give the pilot an unobstructed view. The two propellers are placed close together and contrarotation is effected without gears. Because of its small span, the plane is envisaged as a carrier-borne fighter.

In addition to indicating some of the problems that are involved in the Peel project, the article also reviews other annular designs that preceded it. Brief data are given on the Cedric Lee annular monoplane, the Willoughby Delta model and a scheme suggested by Messrs. Warren and Young. *Flight*, August 3, 1944, page 131, 2 illus.

Tomorrow's Airliners. Accompanied by descriptive data, a group of photographs illustrates aircraft that are being planned by British and American airplane manufacturers for postwar commercial air transport of passengers and cargo. The survey includes planes designed by Douglas Aircraft Company, Inc.; Lockheed Air-



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Quiet,—Please. Leighton Collins. Citing the commercial advantages of soundproofing light planes, the writer suggests several ways in which noise and vibration might be reduced in private airplanes without resulting in too great a weight penalty. Among his recommendations are a double fire wall with soundproofing material sandwiched between; double, vacuum-type windshields and windows; the substitution of curved surfaces for flat ones wherever possible; and shock mounts for the pilot's seat. The writer is of the opinion that to a certain degree performance may be sacrificed to comfort for the greater salability of personal planes. *Air Facts*, October, 1944, pages 28–30.

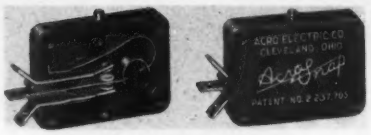
Calculating Shortcuts. Verne W. Van Vlear. In this article the writer presents some calculating shortcuts useful to members of the aircraft industry and the engineering profession. Information is given about a short form of multiplication, exponential simplification, and fractional multiplication. *Weight Engineering*, Fall, 1944, pages 31, 32, 34.

The Design of Struts. R. H. Grundy. The writer presents a simple method of obtaining a suitable strut cross section for a given length and load. It is noted that determination of such a cross section is, under normal circumstances, a tedious trial-and-error task unless comprehensive tables of the properties of the required section are available. The suggested method is stated to permit a close first approximation that is frequently sufficiently accurate to enable the required cross section to be laid out without further trial. The article has particular reference to irregular cross sections. *Aircraft Engineering*, August, 1944, pages 223, 224, 1 illus.

C-54 "Skymaster" Engineering Design Analysis. Edward F. Burton. Design and constructional features of the Douglas C-54 are given in this comprehensive design analysis. Information is provided in great detail regarding the design and construction of the wings, fuselage, empennage, landing gear, hydraulic system, fuel system, lubrication system, and control equipment.

A colored cutaway drawing of the complete airplane and perspective drawings of many of the components show the principal features of the interior construction. *Industrial Aviation*, September, 1944, pages 15, 16, 18–24, 26, 28, 30–32, 35–38, 26 illus.

Standardisation in the Aircraft Industry. Edward Bowyer. The Chief



Designed on the rolling spring principle and actuated by a stainless-steel pin plunger, the new Miniac snap-action switch is only $^{17}/_{64}$ in. thick, $^{13}/_{16}$ in. high, and $1^{3}/_{16}$ in. long. Manufactured by the Acro Electric Company, the switch is rated at 15 amp., 115 volts a.c.

of the Information Department of the Society of British Aircraft Constructors traces the progress of standardization in the British aircraft industry. An outline is given of the results that have been accomplished since 1939, when the country's leading designers, meeting as a committee of the Society of British Aircraft Constructors, agreed to cooperate in a long-term program of aircraft standardization. *The Engineer*, September 8, 1944, pages 182, 183.

After Reading Schildauer and Rosendahl. A commentary on three articles: two written by Capt. C. H. Schildhauer in favor of the flying boat and the third by Admiral C. E. Rosendahl advocating the airship. In reply to the claims made in the discussed articles, the writer concedes certain merits for the flying boats and for the airship, but he also summarizes the limitations of each. His conclusion with regard to the airship is that, although the possibilities of its early commercial practicability are vague, a sound naval program would seem to be in order. Relative to the flying boat, he believes that more experience is needed with the type and that the production of 20 redesigned Martin Mars models for the Navy would be helpful in obtaining that experience. *U. S. Air Services*, September, 1944, pages 16, 18.

Double Duty Design. P. Royal Marshall. The writer offers suggestions as to how aircraft designers can make one structure do two jobs in the interest of weight efficiency. An illustration shows how aircraft interiors lend themselves to double-duty design. *Weight Engineering*, Fall, 1944, page 22, 1 illus.

Electrical Equipment

An Aircraft Differential-Voltage Cutout. O. C. Walley. This article states that one of the major problems on large multi-engined aircraft electric systems is the prevention of the interchange of current between generators when the system is operating at light loads. It is explained that such current interchange causes reverse-current cutouts of conventional design to connect and disconnect their respective generators to the system so rapidly that the action is called "chatter." Conventional cutouts connect the generator to the system when the generator voltage is above a preset value. The differential-voltage reverse-current cutout connects the generator to the system when voltage is a preset value above the system voltage.

Information is given about the design, operation, and advantages of the differential-voltage reverse-current cutout that prevents interchange of current between the generators. *Electrical Engineering*, September, 1944, pages 632–634 (Transactions), 3 illus.

Totalizing Contents of Aircraft Fuel Tanks. J. R. Macintyre. The requirements for totalizing two or more liquid levels in fuel tanks for aircraft are discussed. It is explained that these fall into two broad categories: the first involving the addition of levels where the sequence of use is definitely established; the second, the totalization of several liquid levels in different tanks where the sequence of use is not established but where single indication of the total fuel is desired. In order to explain the operation of the totalizing circuit, the basic principles of a similar circuit when used in a conventional manner are outlined. The writer then discusses sequence totalizing, nonsequence totalizing, and an application of nonsequence totalizing in which the totalizing-indicator element is used to read the total amount of fuel in the three tanks. The advantages gained by making use of totalizing systems instead of the series operation of two or more transmitters often used to accomplish the same results are outlined. *Electrical Engineering*, September, 1944, pages 663–665, 9 illus.

Development of Reduced Voltage Motor Controllers. James F. Carland and P. R. Watson. The writers trace the steps in the evolution of a control system for a motor-driven blower used in connection with a gasoline-burning cabin heater for an airplane. The necessity for avoiding the heavy inrush current of the motor at starting made it imperative to devise a complete system of reduced-voltage starting. The construction and operation of the manual system is explained at length, after which details of the development of an automatic system are given. The accessories and equipment and the functions of the components are described in full, with wiring diagrams and photographs of the complete units. *Aviation*, September, 1944, pages 144, 145, 264, 267, 5 illus.

Auxiliary-Power-Plant Requirements. L. F. O'Neil. The writer describes how some of the limitations with which designers of electrical equipment for aircraft are confronted could be nullified by the use of auxiliary power plants. It is explained that to cover the various phases of application a series of engine-generators would be necessary. A large number of their design features should be adapted to each type of airplane in order to save weight and obtain best performance. It is noted that this would necessitate close cooperation between the designers of the component parts of the plane. Three general types of auxiliary power plants are discussed: battery chargers, bat-

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tery replacers, and independent primary sources of power. *Electrical Engineering*, September, 1944, pages 682–684, (Transactions), 2 illus.

Battery Booster Coils for Airplane-Engine Ignition Systems. A. V. Alvino. Information is supplied regarding the use of battery booster coils and the problems connected therewith. High-voltage and low-voltage booster systems are described.

A low-voltage circuit is shown in which the battery is connected to the magneto primary through the breaker and vibration coil. It is explained that an objection to this system is that no protection is afforded the main magneto in instances when the breaker contacts "freeze." Because of the low resistance of the vibrator and magneto windings, there is a high current flow that will cause demagnetization of the magneto permanent windings and burring out of the magneto primary winding.

A system that overcomes this difficulty is shown. The vibrator circuit differs from the common unit in that the coil consists of a double winding having a common core and common ground.

The primary winding has more turns than the secondary winding, so that for a given magneto-current requirement a lesser amount need be interrupted through the primary winding. It is stated that this feature contributes to the contact life, and, if the contacts "freeze," no induction takes place, since the current will flow through the primary winding to the ground. Under these conditions no harm can be done to the magneto. *Electrical Engineering*, September, 1944, pages 672, 673 (Transactions), 4 illus.

Magnesyn Remote Indication. Robert S. Childs. This article describes the Magnesyn system of remote indication, which was originally applied to remote compass operation but is stated to be equally adaptable to most of the functions which are remotely indicated on aircraft. In order to explain the somewhat involved magnetic circuit of this system, the writer outlines some of the chronological steps in its development. *Electrical Engineering*, September, 1944, pages 679–682 (Transactions), 8 illus.

Engines

More Time Between Engine Overhauls. William Maxfield. Methods are recounted by which T.W.A. maintenance engineers have increased operating hours between engine overhauls from 300 to 750 hours. The procedures described include techniques of disassembly, cleaning, inspection, reconditioning, assembly, and testing. Descriptions are given of the equipment used in these engine-maintenance processes. *Air Transport*, September, 1944, pages 49, 50, 55, 56, 59, 12 illus.

Civil Aircraft Engines. C. H. Potts. An analysis of the trends of engine development for civil aircraft, with comparisons of the liquid-cooled and air-cooled types used by Britain and the United States. The review of development trends traces progress in civil aircraft engines from about 1920 to 1939, notes the changes that have taken place in general aircraft-engine development since 1939, and is followed by predictions regarding the types of engines which will be employed for civil aircraft after the war. Although stating that both liquid- and air-cooled engines will continue to be used in aviation for many years to come, the writer indicates a preference for the radial air-cooled type. In his discussion he also stresses the importance of long overhaul life for the entire power plant as a reliability factor.

The writer's forecast of postwar trends in civil aircraft and aircraft-engine development are summarized as follows: Military types can and will be modified and converted. Liquid-cooled V-type engines will be used immediately after the war as a stop-gap but will be discarded later in favor of other types, especially for outputs above 1,200 hp. The United States will lead the world with the air-cooled radial poppet-valve type. The most useful size of aircraft will be similar to the Avro York, having approximately a total weight of 60,000 lbs. The progress of the larger types of aircraft will depend largely on the development and introduction of a power unit of between 1,500 and 3,000 hp., with an overhaul life of not less than 750 hours. The maximum number of power units for an aircraft will be six. *Flight*, August 10, 1944, pages 157–159, 6 illus.

Flight Technique

"Navigator to Pilot—Over." Capt. Ken Lester. Stressing the importance of cooperation between pilot and navigator, some advice is offered on ways in which they can help each other perform a more efficient job. The experiences of one combat navigator form the basis for the suggestions. Featured among the admonitions to the pilot are the reminders that he hold his altitude, course, and air speed while the navigator is making his celestial observations. *Air Facts*, October, 1944, pages 11–16.

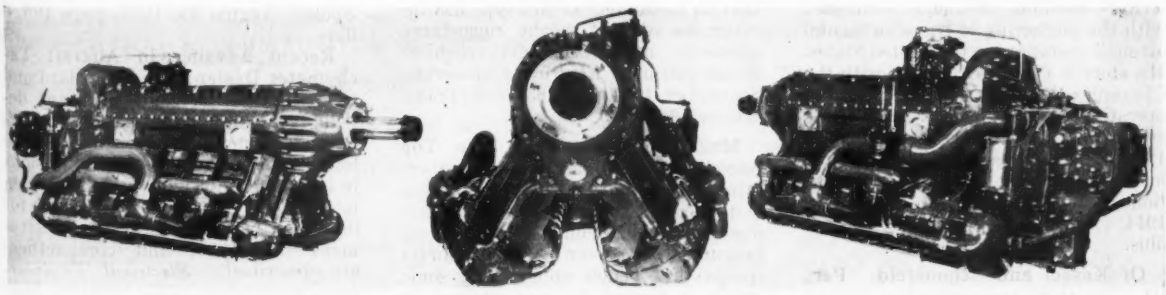
Flight Testing

Structural Flight Research. W. Lavern Howland. Some remarks are made on the history of flight research. It is noted that the general purpose of structural flight research is to determine the magnitude and frequency of various stresses or loads to which the airplane structure is subjected during flight or dynamic conditions. The writer compares the importance and future application of this type of testing with static testing and stress analysis. He also describes the adaptation of wire resistance strain gauges and the equipment used in making flight measurements. Information is given about a few of the many quantities that have been successfully measured. Some of the difficulties and pitfalls that are encountered with this type of testing are discussed. *SAE Journal*, September, 1944, pages 393–400, 444 (Transactions), 16 illus.

Gliding and Soaring

Rocket Powered Gliders. Cedric Giles. A brief historical outline of the application of rocket power to gliders is given by the former president of the American Rocket Society. *Gliding*, September, 1944, pages 9–11, 5 illus.

The "Denver Pioneer" Utility Glider. Eugene M. Ardelt. A description is given of an unusual glider originated through the influence of Caleb F. Gates, Jr., Chancellor of the University of Denver, for solo training in high schools. Information is provided about how the glider was planned and developed. Constructional features of



The new Ranger 700-hp. aircraft engine weighs 870 lbs. complete with standard accessories and develops 700 hp. for take-off with 100-octane standard fuels. The engine is of the 12-cylinder, inverted, air-cooled, "V" type. It has an overall height of 31.11 in., is 74.92 in. long, and 33.28 in. wide. The illustration shows, respectively, the three-quarter front view, front view, and three-quarter rear view.

the glider are listed. The Denver Pioneer is of all-wood construction and consists of a nacelle, wing, and an outrigger to which the empennage is attached. All flying and landing wires that are ordinarily prevalent in a primary trainer are eliminated. The wings, which consist of four box spars, are of wood, braced internally. With the exception of the leading edge, which is plywood, they are covered with fabric. The elevators, stabilizer, and rudder are of the simplest construction possible. The glider has a wing area of about 206 sq.ft. and the span is approximately 42 ft. The aspect ratio is 8.15 and the gross weight is 545 lbs. The wing loading is approximately 2.5 lbs. per sq.ft. *Soaring*, March-April, 1944, pages 10, 12, back cover, 1 illus.

Gliding from a Hayfield Aerodrome. A report of a national glider meet, reputedly the first held in Canada. Conducted by the Gatineau Gliding Club of Ottawa, it took place near Kingsmere, Quebec, from July 1 to July 9, 1944. A total of 173 flights were carried out during the 9-day period by the eleven local club members who participated, together with representatives of two outside clubs. The value of the meet in fostering glider training and development is noted. *Commercial Aviation*, September, 1944, pages 96, 98, 100, 13 illus.

The Great Glider Era Is Just Beginning. Part II. Col. Edward S. Evans, as told to Ward A. Stone. The conclusion of a review of gliding in which a chronology of various events is given. Some comments are made on future glider developments. *Gliding*, September, 1944, pages 2–6, 7 illus.

Gliding Instruction in Europe. Jerzy Illaszewicz. A brief review is given of glider-instruction developments in Europe, with particular reference to Germany, Russia, Poland, and France. It is stated that after the present war it is not unlikely that a glider program will be set up in the countries of the Western hemisphere for purposes of training, science, and sport. *Soaring*, March-April, 1944, page 6.

History

Stories of Early Air Mail Days—and Nights. A. E. Roedel. The writer recounts incidents connected with the pioneering of transcontinental air-mail operations in the United States. His story is concerned mainly with the Cheyenne division of the Post Office operation of the air mail and covers events that took place from 1920 to 1928. Several men who piloted the air-mail planes during that period are mentioned. *U. S. Air Services*, September, 1944, pages 12–14, 42, 44, 48, 3 illus.

Of Kassel and Schonefeld. Part III. The third and concluding part of an article tracing the history of the German firm of Henschel. The writer concludes a step-by-step description of the types of aircraft built by the company. *The Aeroplane Spotter*, August 10, 1944, page 184, 5 illus.

$27,000,000 Ago. Frank H. Ellis. An account of the first aerial expedition over Canada's Hudson Bay area. This expedition took place in 1927 for the purpose of surveying requirements for the safety of ship navigation in adjacent Arctic waters preparatory to the establishment of a Hudson Bay Railway terminal. *Canadian Aviation*, September, 1944, pages 53–56, 92, 94, 11 illus.

Pioneering Without Politics. Capt. H. Shaw. The operations of Aircraft Transport & Travel Ltd. during 1919–1920 are recorded. Calling this British company the world's first commercial air service, the writer tells of its organization, the men who directed it, its air routes, terminals, and equipment. He also includes some information about two competitive air lines—Handley Page Transport, Ltd., and the Instone Air Line. *The Aeroplane*, August 18, 1944, pages 188, 189, 2 illus.; "London-Paris," *Flight*, August 24, 1944, pages 199, 200, 4 illus.

Hydraulics

O-Ring Packings Simplify Lightweight Hydraulic Equipment. Based largely on information supplied by the Mechanical Branch of the Aircraft Laboratory, Air Technical Service Command, this article describes the design of O-ring packings and glands for aircraft hydraulic equipment. The advantages and limitations of O-ring packings for light hydraulic equipment are set forth. Details are given regarding dimensional tolerances, materials, lubrication, finish of running surfaces, frictional characteristics, and causes of failure. Reciprocating, static, and rotary seal applications are considered. *Product Engineering*, September, 1944, pages 581–585, 6 illus.

Inspection

Mathematics of Quality Control. James R. Crawford. An explanation of the numerical basis for statistical quality control. By mathematical interpretation, it is demonstrated how the principle of quality control is based upon an application of a frequency distribution curve representing variations in a group of similar parts which occur according to the laws of chance. Advice is then given on the construction of a control chart showing deviations not chargeable to the laws of chance. Applications of the quality control methods are recommended for the following kinds of inspection problems: measurement of dimensions or hardness; tests of tensile strengths of materials and spot welding; percentage of defective parts in a lot; defects or flaws in finishes, anodizing, cadmium-plating, etc.; defects of insulation per 1,000 ft. of wire; defective rivets in a wing. *Aero Digest*, September 1, 1944, pages 112, 113, 128, 130, 5 illus.

Instruments

A Unique Moving-Magnet Ratio Instrument. F. R. Sias and D. B. Fisk. A description is given of a moving-magnet d.c. ratio-type instrument for the remote indication of oil and coolant temperatures on aircraft. In this instrument the permanent-magnet rotor position and the indication are determined by the fluxes produced by two mutually perpendicular coil groups. One coil group carries substantially constant current; the other carries current which is a function of the temperature bulb resistance.

Instruments of both the single and dual type are described. It is stated that an instrument of this type has the properties of light weight, ruggedness, simplicity, and serviceability required for aircraft use. *Electrical Engineering*, September, 1944, pages 634–636 (Transactions), 12 illus.

Machmeter Measures Safe Top Speeds. An explanation of the operating principles and underlying mathematical theory of the Kollsman-manufactured Machmeter. This is an instrument for measuring the maximum speeds that planes approaching sonic speeds in level flight may attain with safety. It is calibrated to indicate the ratio of true air speed to the local speed of sound showing Mach. Numbers from 0.3 to 1.0 with an accuracy of +0.01 from the calculated value. A schematic drawing of the device is shown, together with a chart giving indicated air speeds and altitudes for various Mach Numbers. *Aviation*, September, 1944, pages 128, 129, 2 illus.

A Complete Height-Finding Device. M. G. V. Bull and A. C. Barrington-Brown. A description is given of how to build an instrument for determining the height of an airplane. The principle of operation is the application of similar triangles. A slide rule is used as the basis on which to build the device. *The Aeroplane Spotter*, August 24, 1944, page 196, 6 illus.

Recent Advances in Aircraft Tachometer Design. R. G. Ballard and C. P. Hall. The results of recent developments in magnetic-drag-type aircraft tachometer equipment are outlined. Improvements and revisions in instrument design which have been made to meet wartime demands for increased temperature range, instrument durability, and compactness are described. *Electrical Engineering*, September, 1944, pages 646–648 (Transactions), 10 illus.

The Pilot Versus the Rate of Climb. William C. Littlejohn. An article in

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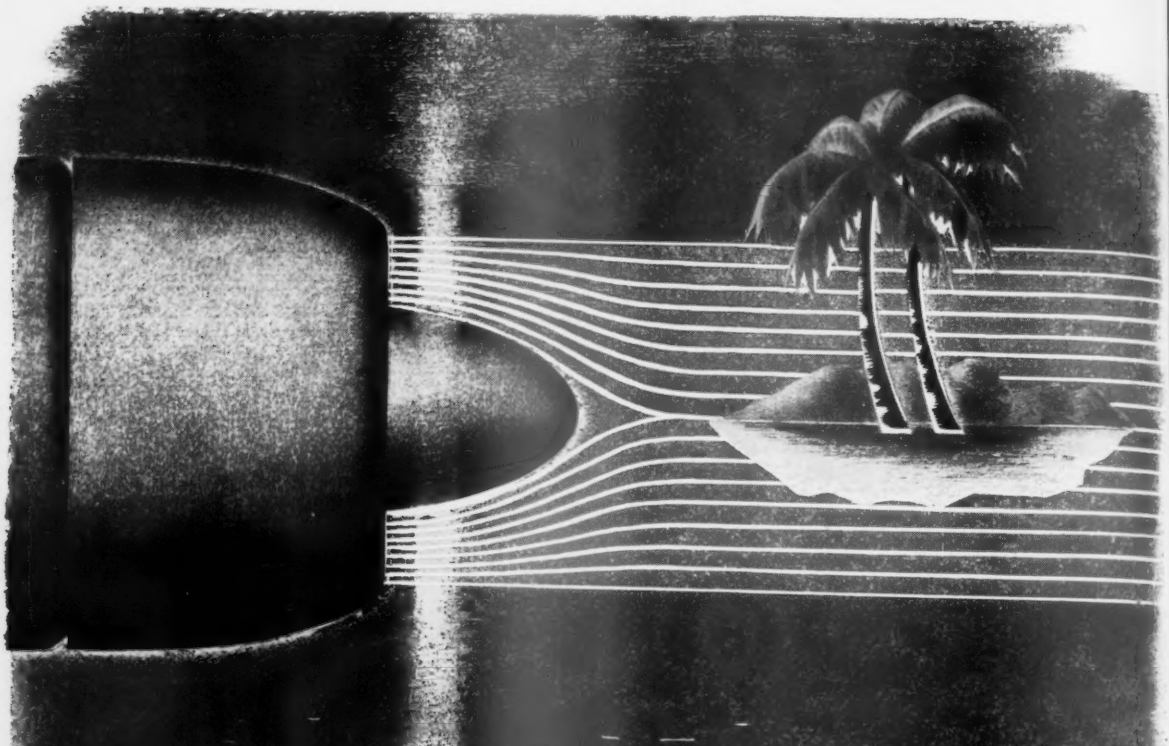
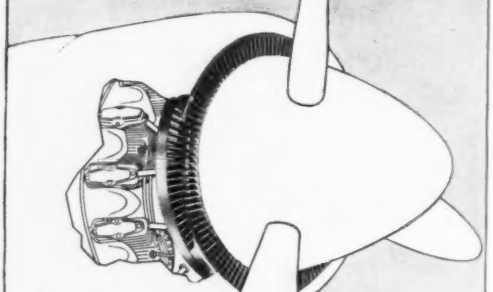


Sea level COOLING in the stratosphere



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refutation of objections to the vertical air-speed indicator. The operating principles and characteristics of this flight instrument are explained, and its advantages over the "air speed, power-setting, altimeter" combination for indicating rate of climb are cited. Advice is given on the proper technique of using and controlling the rate-of-climb indicator in trimming the plane, holding level flight, climbs, let-downs, recovery from unusual positions, and in rough air. *Air Facts*, October, 1944, pages 19–26, 2 illus.

Checking the Angles. A description is given of a plastic propeller protractor which is practically a replica of an aluminum protractor originally used. This protractor is designed to determine, while a plane is on the ground, the angle of pitch of the propeller and to synchronize this angle on all the propellers of a multi-engined plane. *Modern Plastics*, September, 1944, pages 107, 174, 176, 2 illus.

Servicing the A-5 Automatic Pilot. S. C. Atkins. The principle of operation of the Sperry Type A-5 automatic pilot is described, and information is given about the servicing of this instrument. Illustrations show details of the instrument. *Aviation Maintenance*, September, 1944, pages 56, 57, 162, 165–167, 170, 172, 175, 178, 179, 6 illus.

Aircraft-Engine Torque Instruments. F. W. Godsey, Jr., and B. F. Langer. It is stated that flight-operations experience has shown that significant improvements in fuel economy may be obtained through the use of aircraft-engine torque instruments as regular flight instruments. Information is given about the better-known types of torque instruments, and a new type that has come through the development stage is described. *Electrical Engineering*, September, 1944, pages 686–690 (Transactions), 16 illus.

Instrument Failure. Edward A. Diefenbach. The failure of flight instruments to operate under certain weather conditions is noted, and advice is given on how to determine when the instruments are not functioning properly. Behavior of the air-speed indicator, altimeter, rate-of-climb indicator, and gyroscopic instruments under adverse weather conditions is described. A process of elimination forms the basis for the advised system of failure recognition. *Air Facts*, October, 1944, pages 68–71.

Landing Gear

Design for a Castered Landing Gear. C. D. Tucker. Details are given about experiments directed toward the development of a castering landing gear which would make feasible cross-wind landings and take-offs. The writer studied the effects of cross-wind operations on a castered, swiveling undercarriage. It is stated that by incorporating this type of wheel on the

Meeting Army requirements for tolerances no greater than 0.003 in., this plastic propeller protractor is molded of Lumarith X and employs metal only as a band around three sides of the base and for the various screws.

plane the rate of angular acceleration about the normal axis of the aircraft becomes negligible after the first instant the tires make contact with the ground. Thereafter, side load on the wheels does not exist, thus relieving the tendency toward ground looping.

On the take-off, correction for drift immediately after the airplane leaves the ground is not necessary because the angle of drift has been compensated for when using a castering wheel.

Control of the airplane when taxiing, using castering wheels, is no more difficult than with conventional wheels, and the time required in handling planes in the hangar is greatly reduced because a caster-wheel airplane may be pushed in almost any direction. A description is given of an experimental gear that gave the best results. Tests made with both full-castering and controllable-castering wheels are described. *Industrial Aviation*, September, 1944, pages 42–44, 7 illus.

Maintenance

Preventive Maintenance Keeps Motors Young. R. W. Wright and W. W. McCullough. Methods for maintaining electric motors at their maximum efficiency are described. Specific suggestions are given about how to assure the proper mechanical condition of bearings, air gaps, housings, couplings, bandings, commutators, brush riggings, etc. In addition to general data on the prevention and removal of dust and dirt from electric motors, the use of solvents, and the application of varnish, the article also includes note of special points to be observed in the cases of enclosed motors, direct-current motors, and geared motor units. Under average conditions, the following routines are suggested for periodic inspection of electric motors: (1) Every 50 hours—check oil bearings; check temperature of motor bearings and primary iron with the hand; check for overheated insulation by sniffing the warm air coming from open motors. (2) After 100 hours of running—check the brush holders, brushes, and shunts of d.c. motors; blow out the motor with compressed air. (3) At airplane or engine overhaul—check air gap with feeler gauge; check insulation resistance with megger; check line voltage with voltmeter, and load with ammeter; clean out and replace grease in ball or roller bearings; check renewal parts stock in light of past experience; dismantle the motor; see that all windings are tight; replace loose wedges and loose bands before dipping in varnish and baking; inspect commutators and commutator connections; remove the bracket and wash out bearing housing. *Aviation*, September, 1944, pages 162, 163, 249, 251, 2 illus.

Corrosion. The first of a series of articles on the prevention of corrosion, cleaning, and other all-around maintenance problems peculiar to the maintaining and operation of aircraft. The article opens with an outline of the variety of corrosive influences to which aircraft are subjected when in service, which include salt spray and corrosive substances in the exhaust gases from the engines. It is noted that, while commercially pure aluminum alloy is highly corrosion-resistant, many of the aluminum alloys used in aircraft structures are subject to corrosion. Emphasis is placed on the importance of checking the skin of unpainted aircraft at each inspection period. Sections of the article discuss the polishing and waxing of the plane exterior, the cleaning of surfaces, the maintenance of fabric-covered control surfaces, and engine cleaning during regular inspection periods. *Air Tech*, October, 1944, pages 27–29, 58, 7 illus.

Production Line Engine Overhaul. Major Gen. Clements McMullen. A comprehensive explanation is given of the methods and procedures followed at the Fairfield Air Depot of the Fairfield Air Service Command by the Chief of the Maintenance Division of what is now known as the Army Air Forces Air Technical Service Command. He traces the development of a conveyer system for speeding up the work to keep up with the increasing volume of overhaul work. A detailed description is given of the individual operations, including a thorough analysis of each step in the various processes. Drawings showing the layout of the different departments supplement descriptions of the operations of each section, and a tabulation contains condensed instructions for each of the many standardized operations. Information is given about the systems established for keeping records. *Aviation Maintenance*, September, 1944, pages 39–53, 154, 156, 158, 160, 38 illus.

Aircraft Cleaning. Gilbert K. Brower. This article introduces a series in which cleaning materials and processes applicable to the maintenance problems of the air transport industry are examined. In considering the fundamental characteristics and typical requirements of such materials and processes, advice is given on how to obtain

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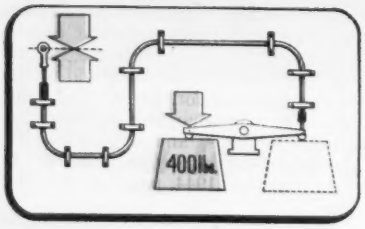

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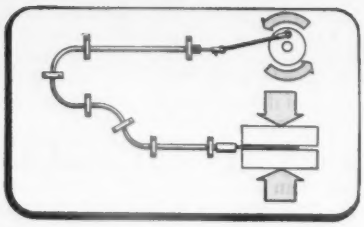
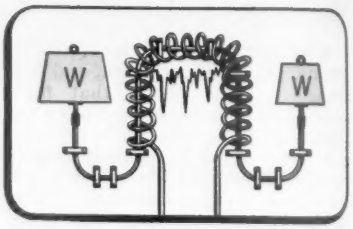
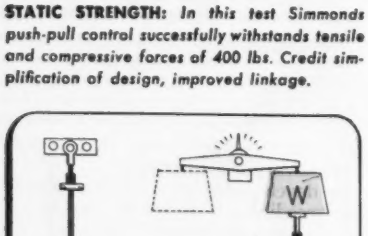


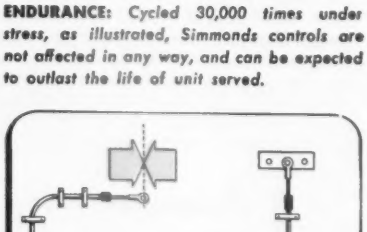
ENDURANCE: *Cycled 30,000 times under stress, as illustrated, Simmonds controls are not affected in any way, and can be expected to outlast the life of unit served.*



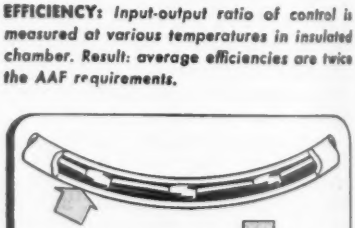
EFFICIENCY: *Input-output ratio of control is measured at various temperatures in insulated chamber. Result: average efficiencies are twice the AAF requirements.*



PRECISION CONTROL: *Motion between tension and compression is negligible. Before endurance test: average—.046"; after—.082". Simmonds are precision-built controls.*



DEFORMATION: *AAF specifications call for loads ranging from 10 to 50 lbs. Allowable average deformation is .140". Simmonds controls average only .083".*



CORROSION: *Simmonds controls meet AAF specifications for corrosion resistance with standard cadmium plated or anodized surfaces. Tube ends are rubber sealed.*

INQUIRIES concerning War Contracts or Post-War problems involving push-pull control equipment are invited. Our service engineers will furnish you gladly with analyses and recommendations. Telephone or write to your nearest Simmonds office.

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and use safer, more efficient, and more economical cleansing methods. The first article contains definitions of terms relating to soaps and other detergents, prepared under the jurisdiction of the American Society for Testing Materials Committee D-12. It outlines the elements of detergency, explaining the factors of wetting power, emulsifying ability, deflocculating power, dissolving power, and rinsability. Besides giving information about the types of soil to be removed, it also describes the classes and characteristics of detergents. The types of detergents investigated are: soaps; alkaline detergents (includes discussion of pH values); synthetic detergents including wetting agents; solvents; and acid cleaners. *Air Transport*, September, 1944, pages 60, 62, 64, 66, 1 illus.

Design for Maintenance. In this article it is pointed out that air-line requirements call for transport airplanes that will provide operating dependability and that to achieve this more attention must be given to details of design. The writer suggests that the time for concentrated consideration on design for maintenance is when a particular project is past the proposal stage and begins to take shape as an experimental design. The application of common-sense engineering is required and also the fullest cooperation between the equipment manufacturer and the air-line operator. It is stated that a partial solution for this accomplishment may lie in the education of the aircraft designer in the operating and maintenance procedures used by the air-line operator in an effort to drive home the effects of improper design caused either by complicated arrangements, poor accessibility, or expensive construction. *Air Tech*, October, 1944, pages 45, 66.

Aircraft Tubing Requires Careful Installation. R. A. Livingston. Procedures are recommended for the care, handling, and installation of aircraft tubing. Information is given about the properties and characteristics of four kinds of tubing: stainless steel tubing for high-pressure hydraulic systems; copper tubing for oxygen systems; soft aluminum tubing for conduit and ventilating systems; and aluminum tubing for low-pressure hydraulic systems. Three types of standard fittings are used on aircraft tubing: the AAF 810 B-nut type, the AN 818, and the AAF 811 BT-nut type. Methods for installing lines, tightening fittings, and preventing dirt, dust, moisture, and denting are particularized. Other advice is pertinent to cleaning, flaring, storing, burnishing, inspecting, lubricating, and forming the tubing. *Aviation*, September, 1944, pages 156–159, 8 illus.

Ingenuity Pays Dividends. Oscar Leiding. A survey of the improvements in methods and equipment instituted by Continental Air Lines to conserve maintenance man-hours. The following are among the devices and procedures reviewed: the changeover from mica-type to ceramic resistor-type spark plugs; a semicircular wheelchock; a testing-device that duplicates an airplane's hydraulic system; specially built turret-lathe fixtures; a master-rod bearing jig; a new technique for installing a diffuser insert oil seal in the supercharger case of the P. & W. 1830 engine; a brake-disc grinder; and a gas-measuring instrument. Other innovations described are: a small knob for reducing window-breakage; an adjustable deicer spout; the salvaging of small tires; alterations to the engine cowl flaps and tail-wheel lock of the company's Lodestars; the redesign of the cockpit control mechanism resulting in a positive unlocking feature; and new type engine cowl-ring attachment fittings. *Air Transport*, September, 1944, pages 40–42, 44, 46, 8 illus.

Management

Weight and Balance Control by the Use of Punched Cards. W. K. Norwick. The use of tabular cards in aircraft weight recording is described in this article, which discusses the system employed at the Fisher Body Division of the General Motors Corporation. Illustrations of the cards are shown, and the advantages of the system are enumerated. *Weight Engineering*, Fall, 1944, pages 43–45, 3 illus.

Materials

Resistance of Common Hardwoods to Compression Perpendicular to the Grain. E. George Stern. The article occupies the entire June issue of the *Bulletin of the Virginia Polytechnic Institute*. It gives a lengthy presentation of test data on moduli of elasticity and stresses at proportional limit in compression perpendicular to the grain of air-dried white oak, red oak, chestnut oak, bitternut hickory, white ash, hard maple, beech, and yellow poplar as influenced by: (1) the physical irregularities in growth and surface conditions; (2) moisture content of the wood within the range of zero to 17 per cent; (3) temperature of the wood within the range of laboratory temperature; (4) rate of strain—that is, motion of crosshead of testing machine of 0.024, 0.050, and 0.100 in. per min.; (5) duration of stress of 1 to 3 min. and (6) repeated loading. Additional data are made available on the variation in thickness of the planed slats as a result of the planing operation. It is shown that the moduli and stresses at the proportional limit vary even within the individual planks as a result of the physical structure of the wood and are influenced to varying degrees by the conditions subjected to tests. No effort is made to give complete data, but the purpose is to indicate the trends to be expected. Load-deformation diagrams for various woods and numerous other charts and tables are included. *Bulletin of the Virginia Polytechnic Institute*, June, 1944.

Rubber and Plastics Plus Metals. John S. Trevor. This article discusses the trend in technological research which is fostering the joining of metals, rubber, and plastics to produce structural combinations possessing many unusual properties. It is stated that expanded rubber in the form of ebonite and the new expanded plastics are ideally suited for use with light metals forming sandwich structures, the center of the sandwich being the ebonite or plastic filler and the outer skins being light alloys such as Duralumin.

It is noted that the term "expanded" is generally reserved for those materials with a cellular, as distinct from a sponge or porous composition. The high insulating property of these new materials and their value as elastic stabilizing media are largely attributable to their unique structure and the presence of countless nonintercommunicating still-air pockets throughout the mass. The properties of various expanded materials are outlined and the use of combinations of rubber, plastics, and metals for aircraft structures is discussed. *Aeronautics*, September, 1944, pages 46, 47.

Choice of Timber for Aircraft. Tom Clark. This is a study of the properties and characteristics of timbers which determine their suitability for aircraft construction. Advice is given on what to look for in selecting the timber that will afford the greatest reliability and safety in the manufactured part. Although characteristics of other woods are mentioned, sitka spruce is used for discussion because of its special adaptability for airplane construction.

With their contributing importance to the choice of timber for aircraft indicated, the following factors are considered: chemical constituents of wood substances, moisture content, variations in densities, differences in Spring and Summer woods, annual rings, and strength and fiber values. Machinery and methods for investigating these factors are described. Procedures of grading wood for aircraft and methods of finding grain inclinations are outlined. Data are also given about the occurrence of dimensional changes in wood, forms of rot and defectiveness, and conditions causing "shakes." *Aero Digest*, September, 15, 1944, pages 93–95, 130, 132, 134, 136, 13 illus.

Strong Cast Aluminum Alloy. Albert J. Matter. The engineering properties of OH38 aluminum alloy are listed and described. Some service-test results obtained with this aluminum alloy, from which high-strength castings can be made without heat-treatment, are given. *Metals and Alloys*, September, 1944, pages 642–644, 3 illus.

Medicine

Problems of Fatigue as Illustrated by Experiences in the Decompression Chamber. John Romano, George L. Engel, E. B. Ferris, Jr., Henry W. Ryder, Joseph P. Webb, and M. A. Blankenhorn. A report on studies of the fatigue experiences of 43 adult subjects exposed repeatedly to simulated altitudes of 35,000 ft. in a decompression

CHIKSAN Aero-Hydraulic Swivels provide required flexibility in brake lines and other hydraulic control systems used in the Lockheed Constellation. Typical Chiksan installation is shown in photo at right.

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chamber. Clinical, psychologic, and laboratory tests were carried out. Three types of fatigue were observed. Muscular fatigue occurred in all subjects. It was unrelated to decompression sickness and disappeared in training. Fatigue related to boredom occurred most often during flights with no decompression sickness when the subject remained inactive at altitude for long periods. The third type of fatigue was not related to muscular effort or to boredom and was delayed in onset. It was experienced by 24 of the 43 subjects. In some instances it occurred only with decompression sickness; in others it was independent of it. It was similar to fatigue previously experienced during or after anxiety situations.

Laboratory data, including the electroencephalogram, blood count, and circulatory reactions to changes in posture, revealed no direct correlation in any type of fatigue. In a few instances damage to tissues subsequent to decompression sickness undoubtedly contributed to the fatigue. These data suggest that emotional factors play an important role in the production of the third type of fatigue. *War Medicine*, August, 1944, pages 102–105.

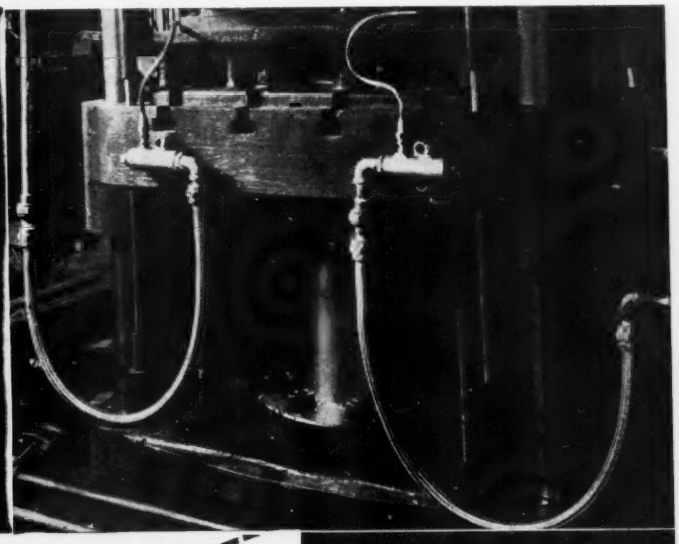
Metallurgy

On the Mechanism of Friction. Bernhard W. Sakmann and John T. Burwell, Jr. If two bodies slide over each other, matter is exchanged between the two surfaces. This exchange of material was studied by means of a radioactive method which made it feasible to detect small traces of material of 10^{-10} gram. Even under the smallest loads of a few grams transferred matter could be detected under dry as well as lubricated conditions. This fact indicated that the exchange of material might be of fundamental importance in all frictional processes, and it seemed desirable to investigate this exchange process systematically.

This paper reports the dependence of this transfer of material on various parameters such as normal load, distance of travel, roughness and hardness of the sliding surfaces, nature of the contacting materials, and lubrication. *Journal of the Aeronautical Sciences*, October, 1944, pages 381–386, 4 illus.

Corrosion Behavior of Magnesium Alloys. H. M. Muncheryan. In opening this article the writer refers to the increasing demand for lighter and stronger aircraft materials which has been instrumental in establishing the commercial importance of magnesium-base alloys. The properties of magnesium alloy are outlined and mention is made of its excellent machining characteristics. It is noted that magnesium alloys can be cast, forged, rolled, or extruded into sheets, rods, tubing, and other shapes. They can also be welded. Magnesium-alloy castings are used principally by the aircraft industry for engine parts, landing wheels, crankcases, gun mounts, oil pumps, and intake manifolds.

SEAMLESS FLEXIBLE METAL TUBING



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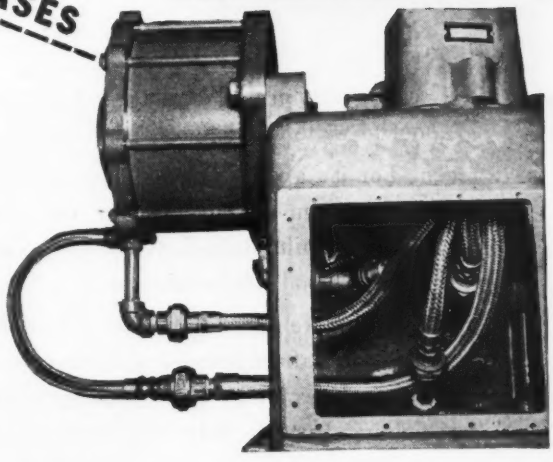

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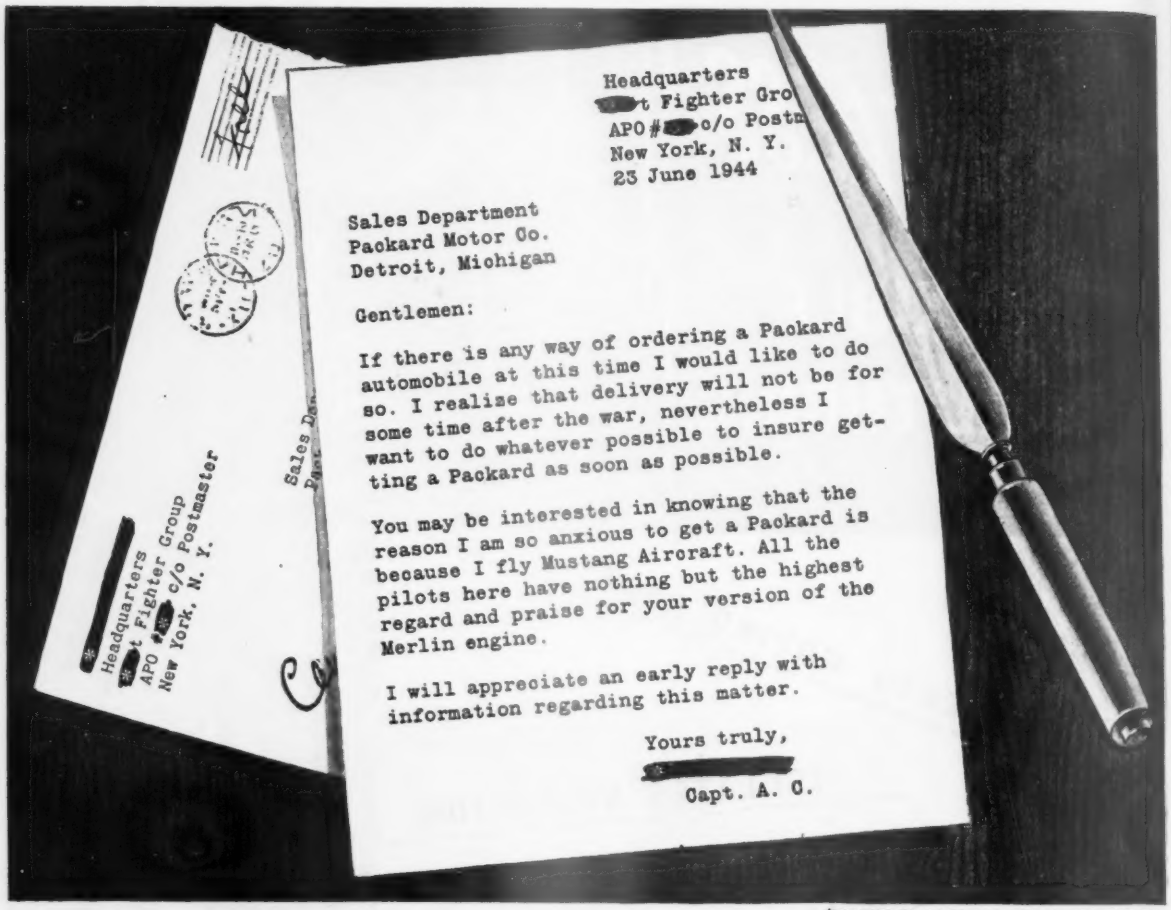
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Headquarters
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We're grateful to the pilot who took time out to write this letter.

For it's always welcome news to hear—right from the boys who fly 'em—that Packard-built Rolls-Royce engines are doing a good job in this war.

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PRECISION-BUILT POWER

It is explained that inclusions of flux particles in magnesium alloy castings in the presence of an electrolyte establishes a continuous chemical reaction that is disastrously corrosive. These inclusions can be prevented by careful foundry procedure. They may also be detected and repaired prior to the installation of castings in service. The article indicates how these faults can be detected and corrected. *The Iron Age*, September 7, 1944, pages 68–72, 9 illus.; "Processing Magnesium to Prevent Corrosion," by Gilbert C. Close. *Industrial Aviation*, September, 1944, pages 46, 48, 101, 3 illus.

Spar Flanges and Other Extrusions. By the Staff of Metallurgy Division, Royal Aircraft Establishment. The chemical compositions and tensile properties of spar flanges and other extrusions taken from enemy aircraft are examined and briefly reviewed. The chemical composition of the parts discussed, and tensile-test results are listed in tables. The analysis is based on 15 German samples and one Japanese sample. *Sheet Metal Industries*, August, 1944, pages 1404, 1405.

The Electron Microscope for Metals. Robert G. Picard and Perry C. Smith. Some of the applications of the electron microscope in metallographic work are discussed, and an outline is given of its use in diffraction studies. Two distinct methods of making electron diffraction patterns are described, one for use with metallic smokes, fine powders, and then films of powdered metals, and the other for studying the surface of solid materials. It is noted that in the electron microscope the use of a beam of electrons instead of light to illuminate the specimen makes it possible to overcome magnification limitations imposed by the nature of light and to obtain magnifications up to 100,000 diameters.

Features of two new commercial-model electron microscopes are described. One is a universal model featuring advances in instrumentation. The other is a simplified semiportable model. *Metals and Alloys*, September, 1944, pages 636–641, 13 illus.

Meteorology

Causes of Nighttime Thunderstorms over the Middle West. D. M. Crowley. Nighttime thunderstorms frequently occur during the summer months over the Middle West. This paper describes this type of thunderstorm, which is initiated and maintained by instability producing conditions other than cold fronts, warm fronts, or thermal instability.

Local superadiabatic instability initiates nighttime thunderstorms, and this instability is produced by any one of the following conditions: (1) advection of warm air at intermediate and high levels; (2) advection of cooler air at intermediate and high levels; and (3) advection of warmer air at intermediate levels and cooler air at higher levels.

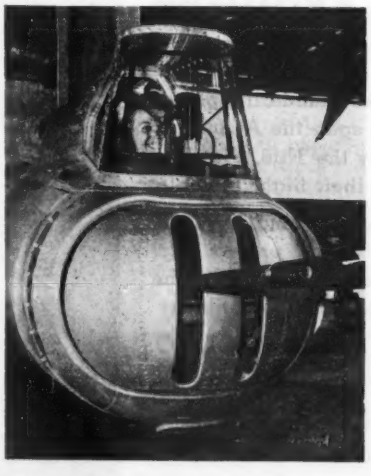
Several typical occasions when these conditions prevailed and produced thunderstorms are described and analyzed. *Journal of the Aeronautical Sciences*, October, 1944, pages 313–318, 17 illus.

Bubbles. Wolfgang Langewiesche. Second article in a series commenting on the theory that weather is caused by updrafts. Following an explanation of how an updraft is started, this second article tells what happens when a "bubble" of warm air is carried aloft. It discusses the resulting phenomena when the updraft meets air conditions tending to limit or promote its buoyancy. The temperature lapse rate is described as an important factor affecting the buoyancy. The formation of cumulus clouds, showers, and thunderstorms is studied.

It is stated that heating causes the rise of the air bubbles, the rise causes the cooling, the cooling causes condensation, the condensation causes new heating, and the new heat causes a new rise. Experiments in artificially producing rain, based upon these theories, are reported. *Air Facts*, October, 1944, pages 73–81.

Military Aviation

The August 25 issue of *The Aeroplane* is concerned mainly with the organization, activities, record, training, and equipment of the Royal Australian Air Force. There are ten articles devoted to this subject. In the first the Prime Minister of Australia tells something of the role played in the war by the R.A.A.F. The second article is a summary of R.A.A.F. activities in the Australian and Pacific theaters of war, in the United Kingdom, and in the Middle East. It includes a report of the decorations and awards won by Australian airmen and officers. The third article describes the R.A.A.F. Air Training Corps; the fourth, the performance history of the Bristol Beaufort. While the fifth article deals with the overseas service of Australian air crews in Britain, in the Middle East, in India and Malaya, the story of their service in the Pacific War is detailed in another article. There are articles on the Mobile Works Wing, development of the R.A.A.F. armament, and Australia's participation in the Empire Air Training Scheme. An account of the duties, operating methods, and accomplishments of Australia's Observer Corps concludes the group.



The new tail swivel turret for the Boeing B-17 bomber gives the tail gunner a 90° swing of fire throughout the cone, as compared with 60° on the old type.

The titles of the articles are as follows: "R.A.A.F. War Record," by The Right Hon. John Curtin, Prime Minister of Australia; "The Royal Australian Air Force," "R.A.A.F. Air Training Corps"; "Bristol-Beaufort Record"; "Oversea Service"; "The Pacific War"; "Mobile Works Wing"; "Armament Development," by Squadron-Leader H. E. Lock; "Empire Air Training Scheme"; "Australia's Observer Corps"; *The Aeroplane*, August 25, 1944, pages 208–229, 52 illus.

The Ninth Air Force. The October issue of *Air News* tells the story of the Ninth Air Force. In a group of 14 articles the history and performance record of the Ninth are reviewed; its organization, functions, fighting tactics, and operating methods are outlined; and its various commands, units, personnel, and equipment are described. Separate articles deal with the work of the pilots, the ground crews, the troop-carrier units, the photographers, the air service personnel, and the liaison fliers. There is also an article pertaining to the work of the Second Tactical Air Force, the R.A.F.'s group in France which corresponds to and cooperates with the U.S. Ninth Air Force. *Air News*, October, 1944.

The Allocation of German Type Numbers—1. A list is given of the type designations of German military airplanes since 1933, with an explanation of the numbering system followed by the German Air Ministry. It includes the name of the maker, type of aircraft, purpose, and the engine with which each is equipped. *The Aeroplane Spotter*, September 7, 1944, page 209.

Naval Aviation

Mobility of U.S. Sea-Air Power is Navy's Trump Card in Pacific. A commentary in which it is pointed out that during the past year certain widely held theories regarding sea-air power have been discredited by actual experience. It is stated that carrier-borne aircraft have become the recognized spearhead of the fleet's striking force, but heavy cruisers and battleships, as well as land-based aircraft, have an important place in the operation. Discussing carriers versus land-based fighters, the writer avers that the theory that carrier-based aircraft have an inherent disadvantage as compared

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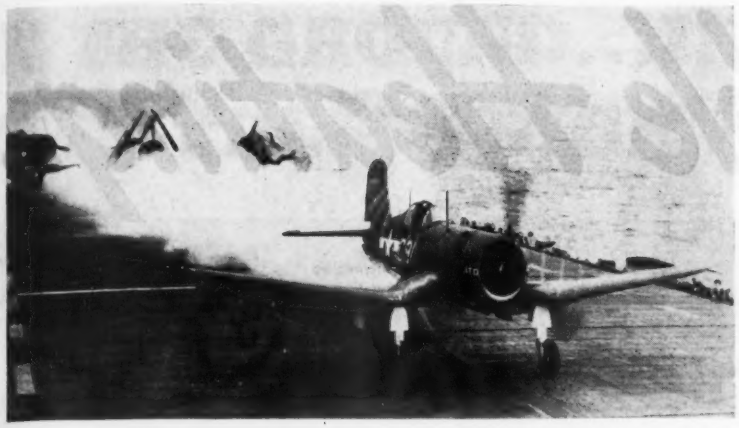

Jet units, which reduce normal take-off runs from 33 to 60 per cent or allow for increase in loads, augment the take-off power of this Chance Vought F4U-1 Corsair fighter.

with land-based fighters has not stood up well. It is stated that the British Seafire and Japanese Zero have performed nearly as well as their land-based counterparts and that the U.S. Navy Hellcat and Corsair are practically as good, and at some levels better, than their opposite number in the A.A.F., the P-47 Thunderbolt. The new Grumman F7F twin-engined fighter (reported as the Tiger Cat) may well be better than any of these, while all are superior to anything the Japanese have yet shown in the Pacific fighting. Their range has been greatly increased by the use of drop tanks; their striking power, by racks carrying 500 or 1,000-lb. bombs and new type launchers for high-velocity aircraft rockets.

The advantage of land-based bombers for long-range sustained attacks is admitted, but one disadvantage with these aircraft is stated to be the need for building extensive bases within range of enemy targets. It is here that the carrier-based dive bombers, despite their smaller load and shorter range, have a big advantage. *Aviation News*, September 25, 1944, pages 21, 22, 3 illus.

U.S. Naval Aviation at War, 1944. The October issue of *Flying* Magazine is devoted to a review of the organization, equipment, and activities of the U.S. Navy's air service. Following a chronological account of the air campaign in the Solomon Islands, there are articles about the carriers, the Catalina searching planes, the fighters, the dive bombers, the scout-observation planes, the night fighters, and the torpedo bombers employed by the Navy. These are accompanied by illustrations of the various types of aircraft mentioned. Then the functions and accomplishments of the utility squadrons, the Naval Air Transport Service, the Marine fliers, the New Zealand air squadrons that have worked side by side with the U.S. Navy in the Pacific, the antisubmarine air patrols, the four-engined bomber searching patrols, and the night-flying Catalinas are described.

One article is concerned with a general character sketch of the Japanese against whom the U.S. Naval aviator must fight; another, with the South Pacific Combat Air Transport Command; a third, with the Seabees; a fourth, with the Coast Guard; and a fifth, with Air Combat Intelligence. The work of the Aerology division, the Lighter-Than-Air groups, the Flight Surgeon, and the crash-boat rescue crews is reported. Information is given about naval air armament, the living and fighting conditions at an advance base, life on a carrier, the manuals that help to train Naval aviators, rehabilitation centers in the Pacific area, and the work done by the WAVES. The issue concludes with articles about the avigator, the air photography groups, survival equipment, air crews, airplane-recognition training, safety equipment, seaplane tenders, and ground crews. *Flying*, October, 1944.

Paints and Coatings

Metallizing Turrett Cylinders. J. M. Crone. This article describes how the difficult problem of metallizing plastic cylinders for gun turrets was solved by the research laboratory of the Airplane Division of Curtiss-Wright Corporation. It is explained that the plastic-metal cylinder is an important part of the fire interrupter for a 0.50-caliber machine gun mounted in the turret. The device prevents the turret gunner from firing into his own plane. The plastic cylinder has upon its convex surface a superimposed plastic pattern or profile of the airplane contour. The balance of the cylinder surface around the pattern is covered with a layer of silver not less than 0.015 in. thick. Electroplating, spraying, and other methods that were tried failed to produce satisfactory bonding of the silver to the plastic. The article tells how the problem was solved by electrical degumming of the plastic cylinder prior to metallizing. *Modern Plastics*, September, 1944, pages 126, 127, 192, 4 illus.

Personalities

They Sparked the Carrier Revolution. Jack Alexander. This is the story of 28 flying officers who fought for and helped to develop carrier aviation in the U.S. Navy. Brief biographical data are given on each of the men, their contributions to carrier-based aviation, and their current activities in the war. The 28 are: Rear Admiral Ballentine, Sherman, Radford, Price, Clark, Pride, Bogan, Hardison, Kendall, Sample, Mullinix, Schoeffel, Davison, Sallada, C. Sprague, Richardson, Wagner, Duncan, Stump, Davis, Henderson, Ginder, Gardner, Ragsdale, McFall, Ofstie, T. Sprague, and Durgin. It is reported that all these men have been made temporary rear admirals within the last year or two. *The Saturday Evening Post*, September 16, 1944, pages 9–11, 46, 48, 50, 52, 28 illus.

Personnel

Post-War Industry. B. J. Stedman. Indicating the importance of trained production engineers for the postwar aircraft industry, the writer expresses his views with regard to the type of training and organization that will engender efficient production-control departments. He differentiates between the specialization and generalization doctrines of training, explains the merits and disadvantages of each, and advocates a reorientation of teaching methods based upon the principle that the study of one particular aspect of a number of specialized subjects should be covered in the production engineer's training. With this type of training as a beginning, he suggests that the production engineering department should consist of a group of people trained in their particular aspect of the operation which is to be carried out. It is his opinion that a single department with one organizer and a suitably staffed personnel trained in the subjects they need is better than a number of separate specialist departments with many heads. The duties and status of the production engineer are also discussed. *Aircraft Production*, September, 1944, pages 452–454.

Photography

Aerial Photograph Interpretation. Michael Goodwin. Information is given in reference to the interpretation of military aerial photographs, and photographic techniques are described. Illustrations show enemy objectives before and after bombing. *Aeronautics*, September, 1944, pages 42–45, 7 illus.

Coated Optical Lenses Have Greater Efficiency. The advantages obtained through the use of a new coating on the lenses of airplane cameras are considered. The coating is said to result in from 10 to 25 per cent greater lens efficiency. It reduces light loss, increases the illumination of the observer's objective, and ex-

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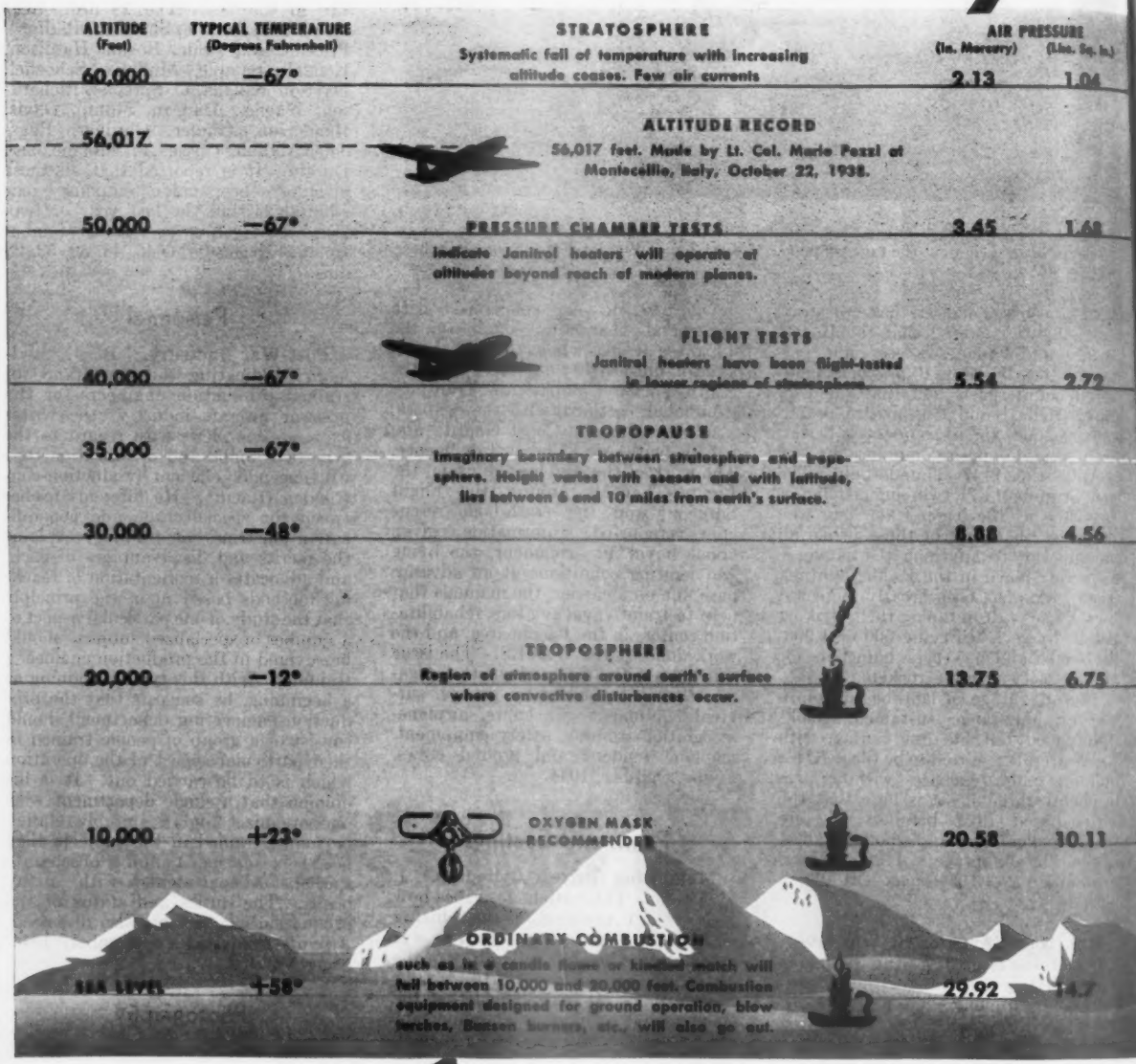

ALTITUDE (Feet)
TYPICAL TEMPERATURE (Degrees Fahrenheit)
AIR PRESSURE (In. Mercury)
(Lbs. Sq. In.)
STRATOSPHERE
Systematic fall of temperature with increasing altitude ceases. Few air currents
60,000 —67° 2.13 1.04
ALTITUDE RECORD
56,017 feet. Made by Lt. Col. Mario Pezzi at Montecelllo, Italy, October 22, 1938.
56,017
50,000 —67° 3.45 1.68
PRESSURE CHAMBER TESTS
Indicate Janitrol heaters will operate at altitudes beyond reach of modern planes.
FLIGHT TESTS
Janitrol heaters have been flight-tested in lower regions of stratosphere
40,000 —67° 5.54 2.72
TROPOPAUSE
Imaginary boundary between stratosphere and troposphere. Height varies with season and with latitude, lies between 6 and 10 miles from earth's surface.
35,000 —67°
30,000 —48° 8.88 4.56
TROPOSPHERE
Region of atmosphere around earth's surface where convective disturbances occur.
20,000 —12° 13.75 6.75
OXYGEN MASK RECOMMENDED
10,000 +23° 20.58 10.11
ORDINARY COMBUSTION
such as in a candle flame or kindled match will fail between 10,000 and 20,000 feet. Combustion equipment designed for ground operation, blow torches, Bunsen burners, etc., will also go out.
SEA LEVEL +58° 29.92 14.7

Janitrol

SURFACE COMBUSTION · TOLEDO 1, OHIO

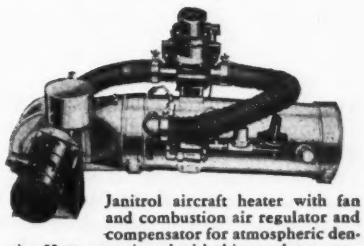
ON THE GROUND...IN FLIGHT... AT EXTREME HIGH ALTITUDES

DEPENDABLE performance at high altitudes is one of the outstanding characteristics of Janitrol Aircraft Heaters. The Whirling Flame principle around which all the Janitrol heaters are designed was specifically developed by Surface Combustion engineers to compensate for rapid changes in air density and temperature at high altitudes.

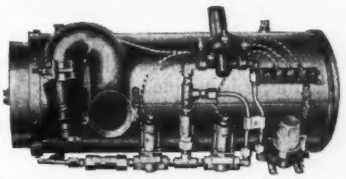
Janitrol Aircraft Heaters, based on the Whirling Flame principle, are now heating Army, Navy and commercial planes in routine flights in the stratosphere, and at intermediate altitudes. In flight they operate on ram air or with fan. And for service in the coldest climates, these heaters can also be fan equipped for preflight ground heating.

These "all-altitude" heaters are lightweight and compact. They require a minimum weight of fuel tubing and duct work. Standard models give capacities ranging from 15,000 to 125,000 B.t.u. per hour output—units with larger capacities will soon be available.

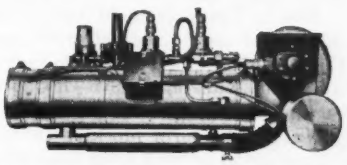
Surface Combustion engineers are ready to work with you and give you the benefit of their wide experience on the application and installation of various types of Janitrol heaters in all types of planes, boats, buses, trucks and other mobile equipment. For complete specification data, write Surface Combustion, Aircraft Heater Division, Toledo 1, Ohio.



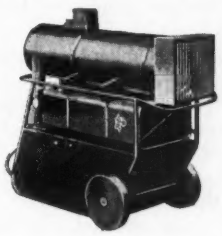
Janitrol aircraft heater with fan and combustion air regulator and compensator for atmospheric density. Heaters equipped with this regulator operate efficiently at highest flying altitudes.



For operation in intermediate altitudes this heater is equipped only with a combustion air relief valve to compensate for changes in volume of air due to changes in plane speed.



For engine and cockpit warming, glass-defrosting and other heating functions on the ground, Janitrol heaters are fan equipped as shown above.



This portable, self-contained ground heater furnishes reliable heat for engines, hangars, work shops, to dry out condensation and for many other purposes, will operate at temperatures as low as 40° below zero.

MAKERS OF:

JANITROL Aircraft and Portable Heaters • JANITROL Gas-Fired Forced Air and Gravity Furnaces, Unit Heaters and Conversion Burners for commercial, industrial and residential heating • S. C. Industrial Heat-Treating Furnaces, Special Atmosphere Generators and Industrial Gas Burners • KATHABAR Humidity Control Systems

Manufacturing Plants at:

TOLEDO, OHIO • COLUMBUS, OHIO

Engineering Offices at:

NEW YORK • CHICAGO • LOS ANGELES SAN FRANCISCO AND OTHER PRINCIPAL CITIES

EASIER, FASTER, LOWER-COST TOOLING WITH FIBERGLAS*-REINFORCED PLASTICS

The combination of Fiberglas and specially developed, low-pressure resins has resulted in a material with many unique and mechanically important characteristics. Lightness, rigidity, dimensional stability, high impact strength and ease of fabrication are among the advantages particularly significant in the production of Fiberglas-reinforced plastic dies, jigs and fixtures.

The high cost of manufacturing metal dies is eliminated. Costly, time-consuming machining is avoided.

FABRICATING FIBERGLAS-REINFORCED PLASTICS

One of the techniques developed, by Douglas Aircraft engineers, for the fabrication of Fiberglas-reinforced plastic jigs is illustrated at the right:

No. 1. The male mold (or, if available, the actual part), backed with plaster of Paris, is placed on a corrugated metal table equipped with air valve for producing vacuum.

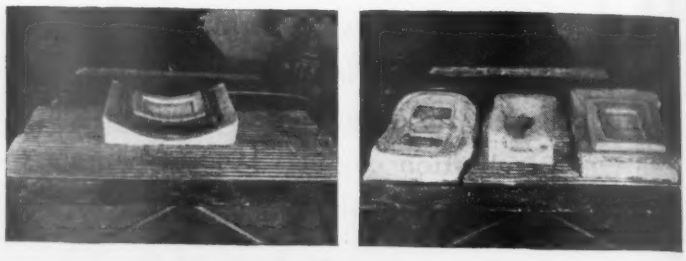
No. 2. The form block is covered with cellophane to prevent resin from sticking to the mold. Then the Fiberglas cloth laminations are trimmed to fit the form block . . . the low-pressure resin is rubbed into the cloth and the desired number of layers are built upon the form block.

No. 3. A rubber blanket is stretched over the mold.

No. 4. Air is evacuated. As the pressure is increased excess resin and air pockets are squeezed out of the laminates. The table is then rolled into the oven to complete polymerization of the resin at about 180° F.

No. 5. After curing and cooling, the form block is removed, flanges are trimmed, holes drilled, clamps installed to complete the tool.

All available fabricating data and additional information about Fiberglas products and Fiberglas-reinforced plastics will be furnished on request. Write: *Owens-Corning Fiberglas Corporation, 1893 Nicholas Building, Toledo 1, Ohio. In Canada, Fiberglas Canada Ltd., Oshawa, Ontario.*



Steps in the production of a jig for spot-welding airplane doors. Fiberglas-reinforced plastics are dimensionally stable, have extremely high impact strength and are nonconductive of electricity.

Photos courtesy: Douglas Aircraft Co., Inc.

ARMY E NAVY

FIBERGLAS.. A BASIC MATERIAL

*T. M. Reg. U. S. Pat. Off.

tends the time during which the camera can be used for daylight exposures. *Aero Digest*, September 1, 1944, page 85, 3 illus.

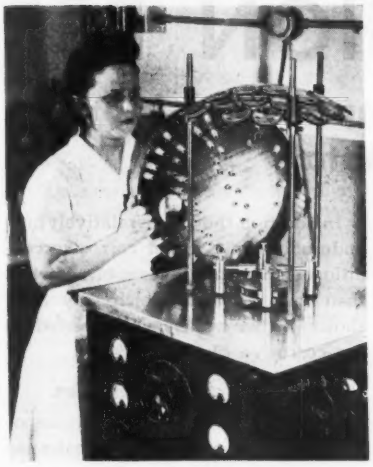
Plastics and Plywood

Effect of Prolonged Heating on Some Physical Properties of Compreg. David Baker and Joseph E. Gurvitch. A report of an investigation undertaken to determine the permanent effect of prolonged heating on some of the physical properties of wood that has been impregnated, laminated, and compressed. The report has special reference to the use of compreg in aircraft propellers. Compreg specimens were subjected to continuous exposure at 160°F. and were tested after various intervals of heating. Complete test results are tabulated. *Modern Plastics*, September, 1944, pages 142, 176, 178, 7 illus.

Analytical Aspects of Plastics. Part I. Harry Barron. Various means whereby plastic materials can be identified are listed and briefly discussed in the first of a series of articles. It is explained that the favorite method of identification by odor can be checked by the methods enumerated. The methods provide a means of proving to which of the many classes of plastics a particular sample belongs. Tables give properties of plastics, such as fluorescence, specific gravity, specific volume, behavior on dry distillation, saponification, chemical content, and solubility. *British Plastics*, August, 1944, pages 339–348.

Phenolic Laminates in Aircraft. Boyd C. Cole. Various aircraft parts manufactured from phenolic laminates by the McQuay Aircraft Corporation are described. An outline is given of how the phenolic fiber sheets that form the base of fairings and ammunition chutes are made. It is noted that the method of forming these flat sheets, which are both light and flexible, is a comparatively recent development. The characteristic of the grades of Micarta used in the aircraft parts discussed are listed, and the average properties of Formica Grade C laminated phenolic plate are given in another table. *Plastics*, October, 1944, pages 50, 51, 90, 4 illus.

Plastics for Aircraft Engineers. W. Nichols. A brief review of basic molding principles in the application of plastics to aircraft manufacture is supplemented by some notes on the design of molded plastic parts. The nature, applications, and procedures for cast plastics, compression molding, transfer molding, and injection molding are outlined. In the design considerations, the factors that are discussed include making sure that the component will be easily removable from the mold, points to be observed with regard to tolerances, wall thickness, and specifications for inserts and threads. *Flight*, August 24, 1944, pages 201–204, 10 illus.



Coating the lenses of aerial cameras with fluoride at a plant of Argus, Incorporated. High-vacuum evaporation is used and heat is supplied by an electrically controlled heater.

Bonding Metal to Wood. Corydon M. Grafton. Information is given about a new series of adhesives for bonding wood to metal without the necessity of baking at elevated temperatures. It is explained that to provide adhesion a plastic base adhesive, Cordo-Bond No. 250 A, is applied to the metal as a priming coat and baked for 15 min. at 250° to 300°F. A low-temperature thermosetting resin, Cordo-Bond No. 200 P, is then applied as a combiner to the primed metal and to the wood. The bonding is accomplished at room temperature. Tables are given which show the dry shear strength and wet shear strength of different combinations of wood and metal bonded by this method. *Modern Plastics*, September, 1944, pages 103, 194, 196, 5 illus.

Plastic Tooling. Melvin Young. A description of how plastic tooling is saving man-hours and materials at the Baltimore plant of The Glenn L. Martin Company, although it is still in an experimental stage of development. It is stated that not only are these savings being affected in the actual construction of the tools and fixtures but in many cases they are reflected on the assembly line where the new tools are used. Both thermoplastic and thermosetting resins are being used in the tooling program, but, so far, the bulk of experimentation has been concentrated on the latter type. Items made from thermosetting phenol-formaldehyde material are enumerated. They include drill jigs, assembly fixtures, spot-welding and torch-welding fixtures, checking fixtures for both in-plant and outside vendor use, and a wide variety of small parts and miscellaneous items. It is explained that plastic tools and parts are cast in wood, Masonite, plaster of Paris, metal, rubber, and latex molds, depending on the nature of the part. The general casting procedure is outlined. Specific applications of plastic tooling are described. *Plastics*, October, 1944, pages 56, 58, 60, 61, 100–102, 11 illus.

Postwar Aviation

From R.A.F. to Civil Aviation. Part I. Squadron Leader G. A. B. Cooper. This is the initial article in a series reviewing the practical problems and possibilities of obtaining jobs in postwar commercial aviation on the strength of experience with the Royal Air Force. After indicating the considerably different techniques required for service and commercial flying, the writer lists a number of questions likely to be asked by individuals seeking careers in civil aviation. These questions are: (1) What sort of jobs does it provide? What sort of life will it be? (2) What qualifications do I need? How do I get them? (3) What are my chances of getting a job? How do I set about getting one? What is the status of the job and what sort of pay may I expect? (4) What is the immediate postwar position likely to be? What is the long-range prospect? How will it be affected by the probably internal and international political and economic position and tendencies?

In this first article, the writer answers the first two questions. He lists 12 classifications of jobs that will be available in civil aviation. He also describes the kind of life that is led by members of an airliner crew under peacetime conditions. *The Aeroplane*, August 4, 1944, pages 125–127.

From R.A.F. to Civil Aviation Part II. Squadron Leader G. A. B. Cooper. Continuing a review of the career possibilities for R.A.F. personnel in postwar commercial aviation, this article outlines the requirements for commercial pilots, navigators, and radio operators and relates how licenses for these three jobs may be obtained. It also considers the importance of operating costs and pay-load considerations to commercial air-line operation. *The Aeroplane*, August 11, 1944, pages 153, 154.

Postwar Private Aircraft. H. Best-Devereux. The writer advocates and enlarges upon a suggestion that parent manufacturers should have priority purchase terms on their own type airplanes when the R.A.F. disposes of its surplus aircraft. He states that the aircraft can then be reconditioned and resold, with beneficial results to the purchaser, the vendor, and Britain's export markets. Then the writer makes a brief summary of the probable types that will command a large part of the private-airplane market immediately after the war: the Fairchild Argus, Piper Cub, Tiger Moth, Magister, Auster, and, in the larger class, the Dominie, Anson, Oxford, and Proctor. *Flight*, August 10, 1944, pages 150, 151.

CORROSION RESISTANCE

...and its importance in aircraft metals

Corrosion is a complicated subject... but many forms of it yield to a simple solution.

All of the INCO Nickel Alloys withstand the attack of *all* these potential corrosion producers:

Marine atmosphere • salt water • compressed oxygen • ethylene glycol (Prestone) • fire-fighting solutions • anhydrous ammonia and other refrigerants • alkalis and numerous acid conditions • tetraethyl lead and other high-octane gasolines and their combustion products.

In addition, the INCO Alloys...Inconel, Nickel, and the various forms of Monel ...have other properties essential to the continuous performance of important aircraft parts.

PITOT-STATIC TUBE, *made by Pioneer Instrument Co., supplies true pitot and static pressures to Rate of Climb Indicator, Sensitive Altimeter, and Airspeed Indicator. A Monel sealed tube body prevents air erosion, increases structural rigidity, and resists corrosive attack. Within the tube, a Monel sheath protects the heating element from corrosive effects of moisture seepage.*

"Plus" Properties of Inco Nickel Alloys

All are strong and tough. Each possesses specialized properties...*extra hardness*, in "K" Monel; *fast-machining*, in "R" Monel; *extra heat resistance*, in Inconel; etc....which fits it for specialized jobs.

Corrosion tests conducted in marine atmospheres show uniformly high resistance by all 8 INCO Nickel Alloys. Some surface discoloration may occur ...but there is no loss in tensile strength.

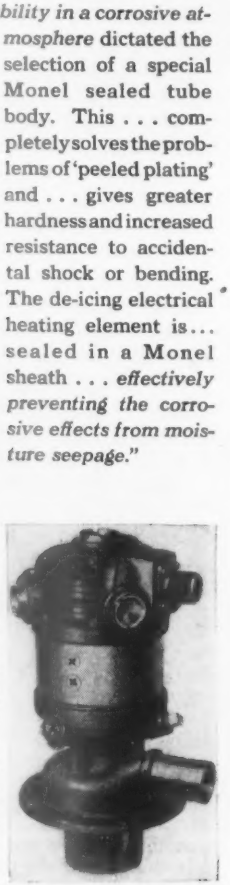
In addition, they have relatively high endurance limits under corrosive conditions. Their endurance is often better than that of steels which may have shown higher values when tested in non-corrosive surroundings.

Four Practical Examples

Typical of the important service of INCO Nickel Alloys in aircraft is the use of Monel in the Pitot-Static Tube, made by Pioneer Instrument Company.

Since three vital flight instruments depend upon its accuracy, the Pitot-Static Tube must deliver true pressures from the air stream under all flying conditions.

In the words of the makers..."The problem of *durability in a corrosive atmosphere* dictated the selection of a special Monel sealed tube body. This . . . completely solves the problems of 'peeled plating' and . . . gives greater hardness and increased resistance to accidental shock or bending. The de-icing electrical heating element is... sealed in a Monel sheath . . . *effectively preventing the corrosive effects from moisture seepage.*"



FUEL-BOOSTER PUMP, *made by Thompson Products, Inc., guards high-flying planes against bubbles in gas tank. Monel rotating cup seal and seal gasket retaining washer are, in words of Pioneer engineers, "extremely important to life and proper functioning of pump." Monel bypass valve washer and valve guide-cup are also used.*

Another example is the use of Inconel exhaust manifolds on Pan-American Clippers. The manifolds withstand constant vibration and *the continuous blast of corrosive high-octane exhaust gases at 1500° F.*

Since Monel is practically immune to corrosion by high-octane aviation fuels, it is widely used throughout fuel lines for strainers, screens, valve parts, primer tubes, fuel selector valves and fuel pumps.

STRAINER FOR AVIATION FUEL NOZZLE *is made of Monel wire cloth... resists corrosion by high octane fuels and by atmosphere. Monel wire cloth is electrically welded . . . illustrating workable properties of Monel.*

One such use is the Monel wire cloth strainer for aviation fuel nozzles, made by Michigan Wire Cloth Co., Detroit.

Another is the use of Monel in the Fuel Booster Pump, made by Thompson Products, Inc.,... the pump which confines within the tank the millions of bubbles that form in gasoline at high altitudes and would cause vapor lock and engine failure if allowed to pass into the fuel lines.

* * *

For further data about corrosion as it affects the choice of aircraft metals...and for other valuable information about the INCO Nickel Alloys (high and low temperature properties, heat transfer, mechanical properties, fabrication, etc.) write for the new booklet, "INCO Nickel Alloys for the Aircraft Industry." Address:

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Sheet...Strip...Rod...Tubing...Wire...Castings...Welding Rods

No Miracles for Private Flying. Leslie H. Bowman. Some observations with regard to private planes and private flying after the war, culled from a tour of factories throughout the country. The writer's opinions are given about who will manufacture private planes after the war, the numbers and types of planes that will be available in the immediate postwar period, and the kind of airplane that will sell in quantities. His list of required features for postwar private aircraft include the following: pusher installation, roomy cabin, and fixed landing gear, which would be either tricycle or four-wheeled. Specifications are outlined for two basic types of private airplanes. One is a light, two-place aircraft designed to sell at two or three price levels between $1,000 and $3,000 and powered with 75- to 90-hp. engines. The other is a four-place plane with an engine of from 140 to 185 hp. and a selling price from $3,750 to $4,500. *Southern Flight*, September, 1944, pages 36, 37, 72, 76, 1 illus.

Polish Air Transportation. Cz. Kierzkowski and H. J. Górecki. The writers review the development of air transportation in Poland up to the outbreak of the war and discuss the prospects for postwar expansion. A table shows the yearly increase in the length of Polish air lines from 1922 to 1939. The activities of the Polish air transport during the last decade are summarized. *Air Transportation*, August, 1944, pages 10–12, 2 illus.

"Operating Obstacles" May Delay Growth. E. J. Foley. The writer indicates certain operating obstacles that threaten to delay postwar expansion of flying. With regard to private flying, he states that three of these are weather, the congestion of large cities, and the so-called "planner" who would surround the metropolitan areas with transport airports, taking up most of the flying space and leaving little for the private flier. The writer believes that the recognition of sound airport design practice and economics will suppress the enthusiasm of planners of satellite airports. He emphasizes the difficulties of transfers from one small airport to another and the problems of air-traffic congestion and reiterates his opinions about the future importance of air cargo. Other subjects considered are simplified traffic-control facilities and the probable attitude of commercial pilots about the size of future airplanes. *American Aviation*, October 1, 1944, page 60.

Over the Top to Siberia. Frederick R. Neely. The prospects and value of air routes between the United States and Siberia are investigated. Siberia is pictured as a country of vast economic and commercial potentialities which, by reason of natural conditions, can best be traversed by air routes. Russia's plans to establish trans-continental and feeder air lines in Siberia after the war are noted; an indication of her favorable attitude toward an interchange of landing rights and routes between the United States and the U.S.S.R. is seen. The article also contains some data on the different round-the-world air routes that have been proposed by several air lines in the United States. *Collier's*, September 23, 1944, pages 16, 17, 91, 1 illus.

European Air Transport. This article is one of a series expressing the views of various European nationals with regard to air transport after the war. In it the Inspector of the Czechoslovak air force outlines his country's ambitions with regard to air transport development and indicates the contributions which Czechoslovakia can make toward such development in Europe. Urging the need for world conference, he envisages the establishment and conduct of future transatlantic, transcontinental, and trans-European trunk routes as the result of international collaboration. His views are also given on how the experience of Czechoslovak pilots gained during the present war will affect the revival of Czechoslovakian aviation; expedient methods of solving the problems of civil aircraft shortages; a United Nations policy toward German aviation; and the possibilities of a postwar link between the U.S.S.R. and Czechoslovakia in the field of civil air transport. The article is presented as a succession of questions and answers. *Flight*, August 3, 1944, pages 129, 130.

Bids for Air Traffic. T. D. Slattery. The part the British railroads will take in the postwar expansion of air transport is discussed. The writer describes the position of the railroads before the war and how it developed under war conditions. He then outlines the postwar plans of the railroads. *Air Transportation*, August, 1944, pages 14–16, 1 illus.

A Preface to Postwar Planning. Part VIII. George E. Haddaway. The eighth article in a series dealing with various problems that require solution in the establishment of a sound postwar aviation program for the United States. Part VIII is concerned with Federal sovereignty of airspace. Legal substantiation is offered of the contentions that all navigable airspace is already federalized and that states that attempt to regulate air transportation are operating out of their province. The Civil Aeronautics Board is accused of having failed in its ministerial duty to take action against so-called interstate carriers and aviation commissions established by certain states. *Southern Flight*, September, 1944, pages 44–46, 1 illus.

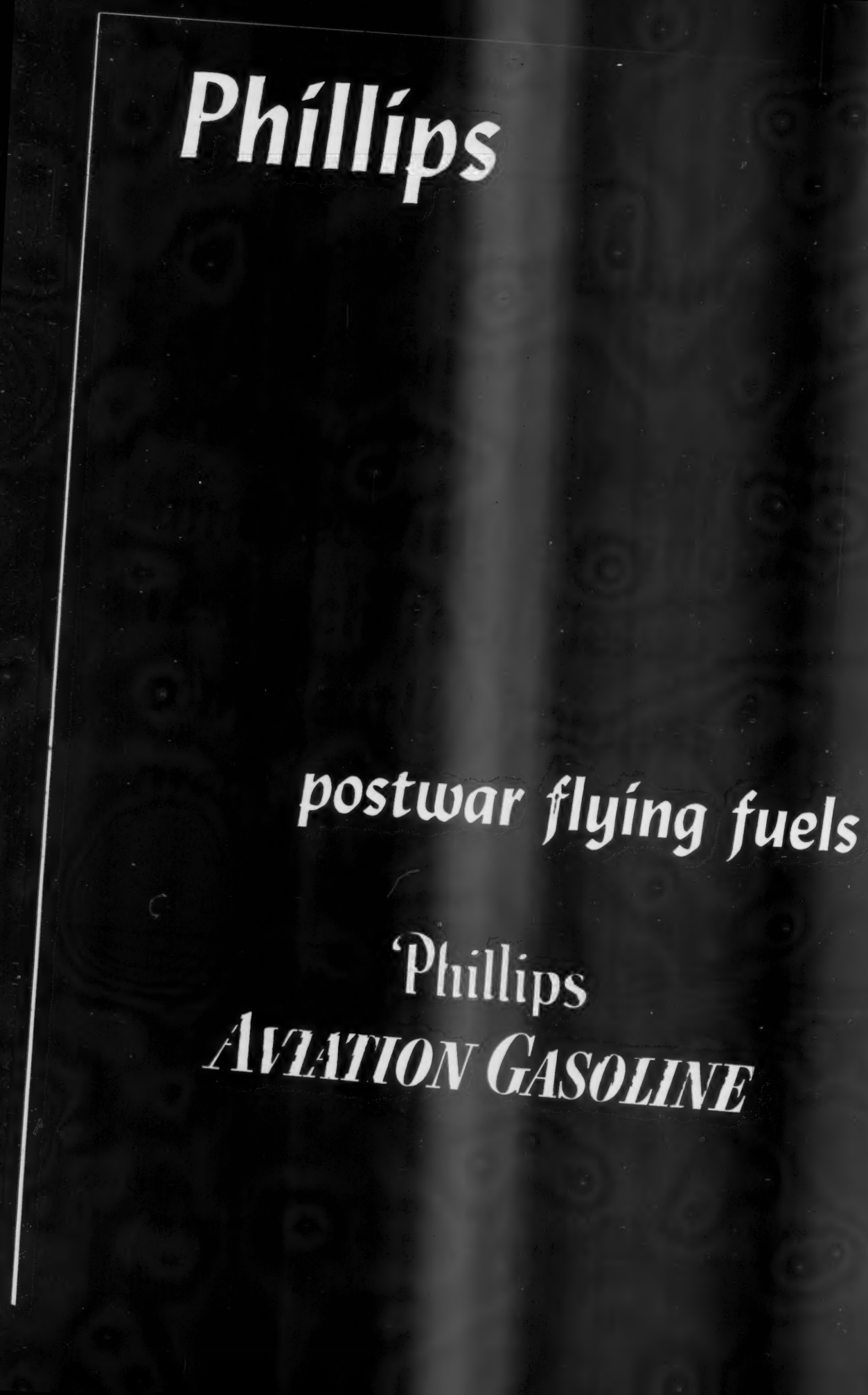
Where Next? Edward Warner. The first of two articles by the Vice-Chairman of the Civil Aeronautics Board analyzing the extent of future air-line traffic and discussing how the traffic will be handled. In this article it is reasoned that the growth in air-line business will depend upon the relative rates of fare charged by the various forms of transportation, the change in quality of their services as compared with the prewar period, and the extent to which the advantages of air travel create new passenger movements. The conclusion is that, just so far as the endeavor to reduce air-rail fare ratios is successful, the air transport industry will progress from a potential of some 5,500,000 passenger-miles annually to one more than four times as great.

Considering how the reductions in cost may be effected, the writer investigates the comparative economy of operating with aircraft of the size of the DC-3 and with smaller airplanes. Although he shows that the operating cost per seat-mile for the DC-3 is almost a third less than for the most economical aircraft of half its seating capacity, he states that it will probably be advisable in some cases to accept the economic handicap of keeping to smaller aircraft in the interests of increased frequency of operation. Aerodynamic improvements and maintenance efficiency are noted as other methods of reducing costs. The rates indicated as likely to be the minimum charged for air-passenger travel after the war are from 3 to 4 cents a mile; the number of aircraft required for this purpose is estimated at 600 to 800 aircraft of 40-passenger or more capacity and about 300 of the smaller sizes. *Air Transport*, September, 1944, pages 32–37, 4 illus.

Yugoslavia and Aviation. A Yugoslav's opinions regarding his country's role in postwar European civil aviation are reviewed in this article, one of a series expressing the views of various European nationals on the subject. Reporting on the history and development of civil aviation in Yugoslavia up until the war, the writer claims that postwar plans for civil aviation in Yugoslavia are dependent upon full international cooperation and territorial safeguards, since Yugoslavia's big neighbors are the "Axis" countries. Some of the political, economic, and technical problems with which Yugoslavia must cope in connection with future air service and policy are indicated. *Flight*, August 10, 1944, pages 155, 156.

Private Flying

Ruminations of a Dub. Devon Francis. A discussion of some problems that are of concern to private pilots who, before the war, were accustomed to flying from about 15 to 50 hours a year. The problems are stated in the form of questions: What is the status of the certificates of such pilots? To what extent is the government going to regulate private flying after the war? Is the industry going to have "safe" airplanes available for these pilots after the war? When will the manufacturers take such care in the selection of their distributors and retailers that people who sell and service airplanes will approximate the courtesy shown by automobile agencies? In expressing his opinions as to what the "15 to 50 hour" pilots want, the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postwar flying fuels
Phillips
AVIATION GASOLINE

writer claims that their preference is for shorter runways instead of longer and for landing areas instead of elaborate airports. He also suggests that private pilots be taxed on fuel purchases and that the money be used for establishing flying airways, marked by signs on the ground at 2-mile intervals. *Air Facts*, October, 1944, pages 40, 41, 44–46.

Production

Charting Steers Shop's Course on the Superfortress. Chester S. Ricker. This article deals with the Chart Room of The Glen L. Martin Company's Nebraska plant and the visible production control system instituted there for the contract-manufacture of Superfortress planes. Emphasizing "shortages" or departures from scheduled dates of completion, this system has two functions: first, to show such shortages; second, to record work progress. It does not show total inventories. Details are given on how the system is set up and how it operates. Its pertinence to the work of the Production Planning Section, the Dispatch Department, and the Project Group is indicated. Several drawings illustrate the records in the Chart Room, and a table lists the typical production-analysis. *Wings*, October, 1944, pages 1229–1233, 6 illus.

New Forms Aid in Simplifying Parts Spoilage Control. Charles H. Brown. A means for controlling parts spoilage is discussed. The system is a "paper control" one based upon the use of two forms: a record-of-disbursement card and a floor-replacement ticket. *Aero Digest*, September 1, 1944, page 102, 1 illus.

Standards for Surface Quality and Machine Finish Designation. James A. Broadston. This first of a series of articles on surface finish discusses passible effects of surface quality on the strength and functioning of machine or structural members. The writer describes surface irregularities that define quality. He gives information regarding methods of measuring roughness and describes standard roughness values. *Product Engineering*, September, 1944, pages 622–625, 6 illus.

Profile Milling Saves Forging Die Costs. Alex Maxroczy. This is an account of a process developed in the machine shop of the Columbus plant of the Curtiss-Wright Corporation for providing several aircraft wing hinges of new design, for experimental testing. The production of forging dies for this job would have cost approximately $75,000, and an effort was made to save this expense by producing the required trial pieces entirely by machining. A description is given of the solution of this problem, with information about the special tools and equipment used. The numerous illustrations show progressive steps in the process. *Machinery*, September, 1944, pages 184, 185, 8 illus.

Flange Rolling Improves Quality, Speeds Output. A description of how the Curtiss-Wright Corporation fabricates flanged bushings by means of a flange-rolling machine employing backing and forming rolls and a heating unit. In addition to effecting a timesaving of approximately 2 min. per unit, this machine is said to produce bushings that are superior in construction to welded or riveted types because of the fact that the flange is part of the body metal. It was designed by two employees of the company.

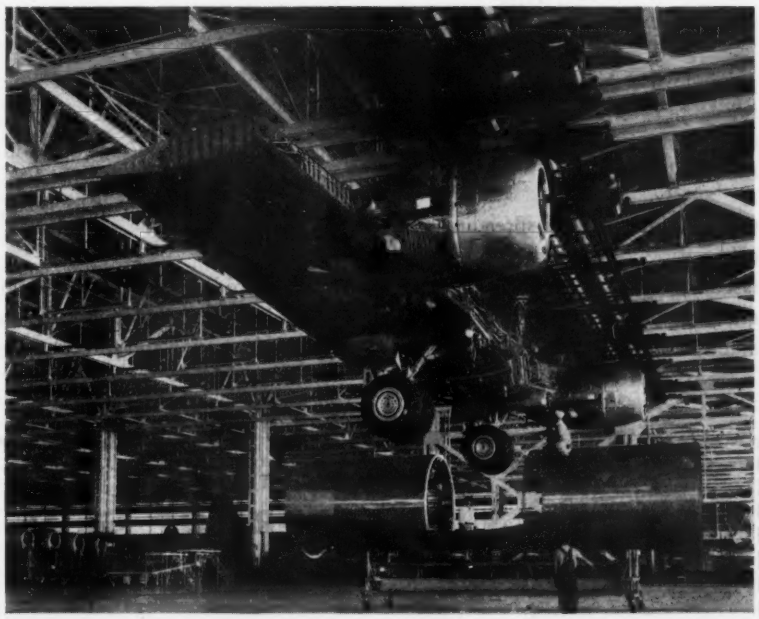
In the flange-rolling method the metal is heated until it has attained a plastic state, and a series of press operations follows. During the process the metal is rotated so that it is worked uniformly and is supported by backing rolls that control the flange formation. A series of forming rolls completes the steps so that the metal may be shaped into any desired contours. Photographs depict the sequence of operations and illustrate details of the equipment. *Aviation*, September, 1944, pages 146, 147, 249, 5 illus.

Machining of Light Alloys with Diamond Tools. The advantages of diamonds as a cutting material are summarized. The use of diamond tools is discussed with particular reference to the machining of aluminum-alloy pistons. Sections of the article deal with cutting angles for turning tools, economical cutting speeds, the rate of feed and the depth of the cut, and the cutting force. The boring of piston-pin holes is considered. *Light Metals*, September, 1944, pages 430–436, 18 illus.

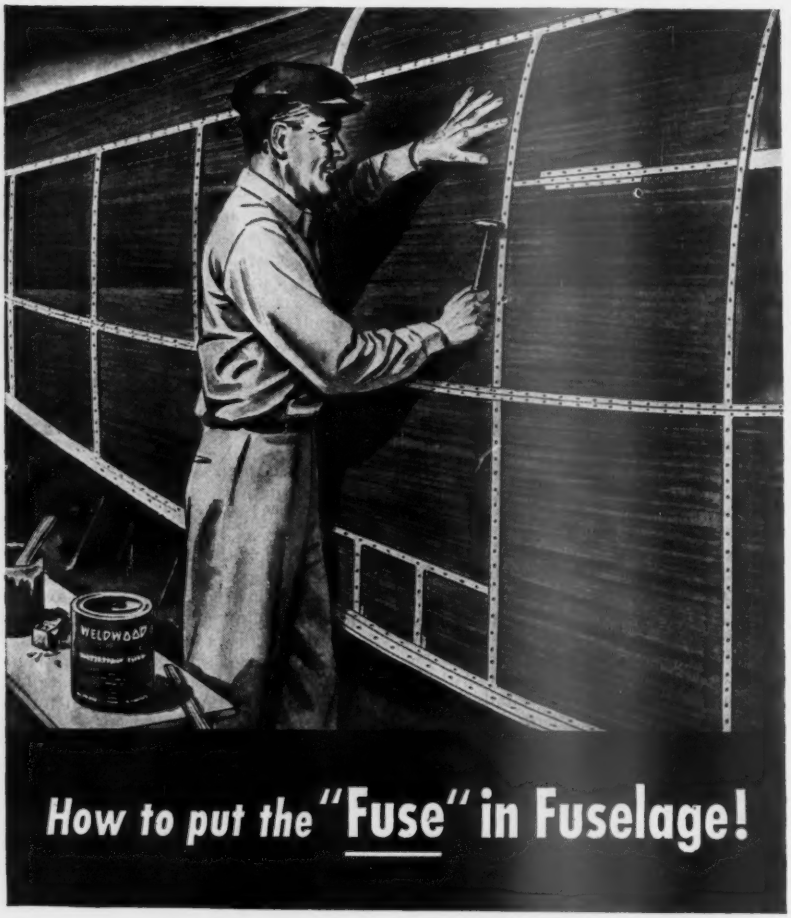
Induction Heating in Airframe Manufacture. Gilbert C. Close. This article details methods, advantages, and applications of high-frequency induction heating in air-frame production. It explains the theory of the induction-heating process and describes the three types of induction-heating units commonly used: the motor-generator, quenched spark-gap, and electronic tube. Power output, frequency range, and applications of each type are listed.

Among the advantages claimed for high-frequency induction methods of heating metal are: The quality of the work produced is very high; the unit may be adapted to any number of different functions with slight modifications, thereby reducing tooling cost; the induction heaters may be conveniently located to minimize factory routing of parts; several different kinds of production processes can be performed on the same machine; and either light or heavy alloys may be processed. Procedures that are discussed are connected with the following applications: heating of spar caps prior to hot forming; surface hardening of gears, shafts, bushings, and other wearing parts; brazing; continuous-strip and edge hardening; localized hardening; and melting of metals. *Western Flying*, September, 1944, pages 44, 45, 90, 92, 7 illus.

Tubes with Reduced Ends for Light Tubular Structures. Arthur Z. Bendar. Methods of reducing the diameter of round tube ends that permit more efficient applications of tub-



The 17-ton main center wing section of a Boeing B-29 Superfortress is lowered to join the fuselage bomb bay section at the Wichita, Kan., Division plant of Boeing Airplane Company.



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ing to aircraft structural subassemblies are described. Illustrations show proper design. Common reducing and swaging methods are compared, and a table shows dimensional tolerances for reduced tube ends. *Product Engineering*, September, 1944, pages 635–637, 5 illus.

De Soto Builds B-29 Components. Franklin M. Reck. Methods by which the De Soto Division of the Chrysler Corporation fabricates parts for the Superfortress are reviewed. Described procedures are those connected with the manufacture and assembly of the B-29's pressurized nose section, leading edges, and engine cowling. Attention is called particularly to the work of the Wiring Department, the Quick Change Department (an organization for facilitating the institution of modifications in the production line), and the Rework Department. The review stresses the fact that De Soto follows automotive principles as far as possible in all its aircraft contracts. *Aero Digest*, September 1, 1944, pages 80, 81, 128, 4 illus.

Designing of Castings and Forgings. Part IV. James E. Thompson. The fourth part of a continued article about castings and forgings deals with drafting practice. Careful preparation of drawings is urged for all cases, not only because costs can thereby be reduced but to save actual material and man-hours wasted in correcting errors. It is noted that in the past separate sets of drawings have been made for machining certain kinds of forgings where it is the custom to manufacture a limited number of "pseudo-forgings" from bar or billet stock for use in the first few airplanes of a new design to avoid delays while awaiting delivery of regular forgings. The writer states that it is better practice to maintain the same standards for the pseudo-forgings and use the same drawing numbers, because there is no functional difference in the actual parts. The same drawings should also be used to facilitate the keeping of records in many different departments of the plant. It is recommended that proposed designs of cast or forged parts be submitted to the vendor or subcontractor who is to produce them so that advantage can be taken of practical experience in production and so that clear understanding may be obtained before the design is established.

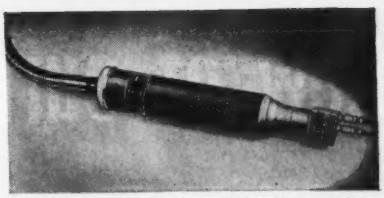
For simple sand or permanent-mold castings a single drawing can be used for both the rough and machined part. Suggestions are offered for making a combination drawing to show the dimensions for preparation of the pattern and for all machining operations. Involved dimensioning for large and complex castings frequently causes confusion, so separate drawings are advised, for which detailed instructions are given. It is emphasized that drawings should show not only how to draw the part but how to make it. For die and pressure-mold castings, the same general drafting practices are followed except

This simple operation is the final proof that Machlett has succeeded in producing malleable beryllium, for here that metal is being rolled into sheets from 0.004 to 0.020 inch thick, sheets that are vacuum-tight, and have adequate ductility at high temperatures. Such properties were once considered impossible to realize.

Why was it important to produce the metal in this rare form? Because beryllium was known to be remarkably transparent to X-rays, and if it could be used as a window in the tube envelope, a great improvement would be made in tubes for several important applications — particularly X-ray diffraction. One such application is determining the axes of quartz crystals (important in war radio); there are manifold similar vital technical uses in metallographic investigations.

So Machlett did the impossible — beryllium was made malleable. Details are to be found in a scientific paper, copies of which will be sent to you on request.

Such an achievement is typical of the Machlett determination to overcome even the greatest obstacles to the production of the most effective and desirable types of vacuum tubes, whether they be X-ray tubes for medical, dental, industrial or scientific purposes, or are radio tubes for communications or induction heating. The technique that produces "impossible" malleable beryllium makes possible the tube illustrated above . . . Machlett Laboratories, Inc., Springdale, Connecticut.



Machlett Diffraction Tube with beryllium window. Used in analyzing quartz crystals for war and other radio purposes, and in metallography.

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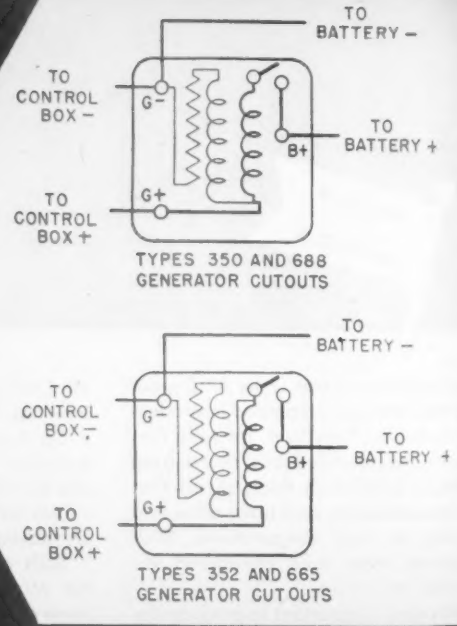

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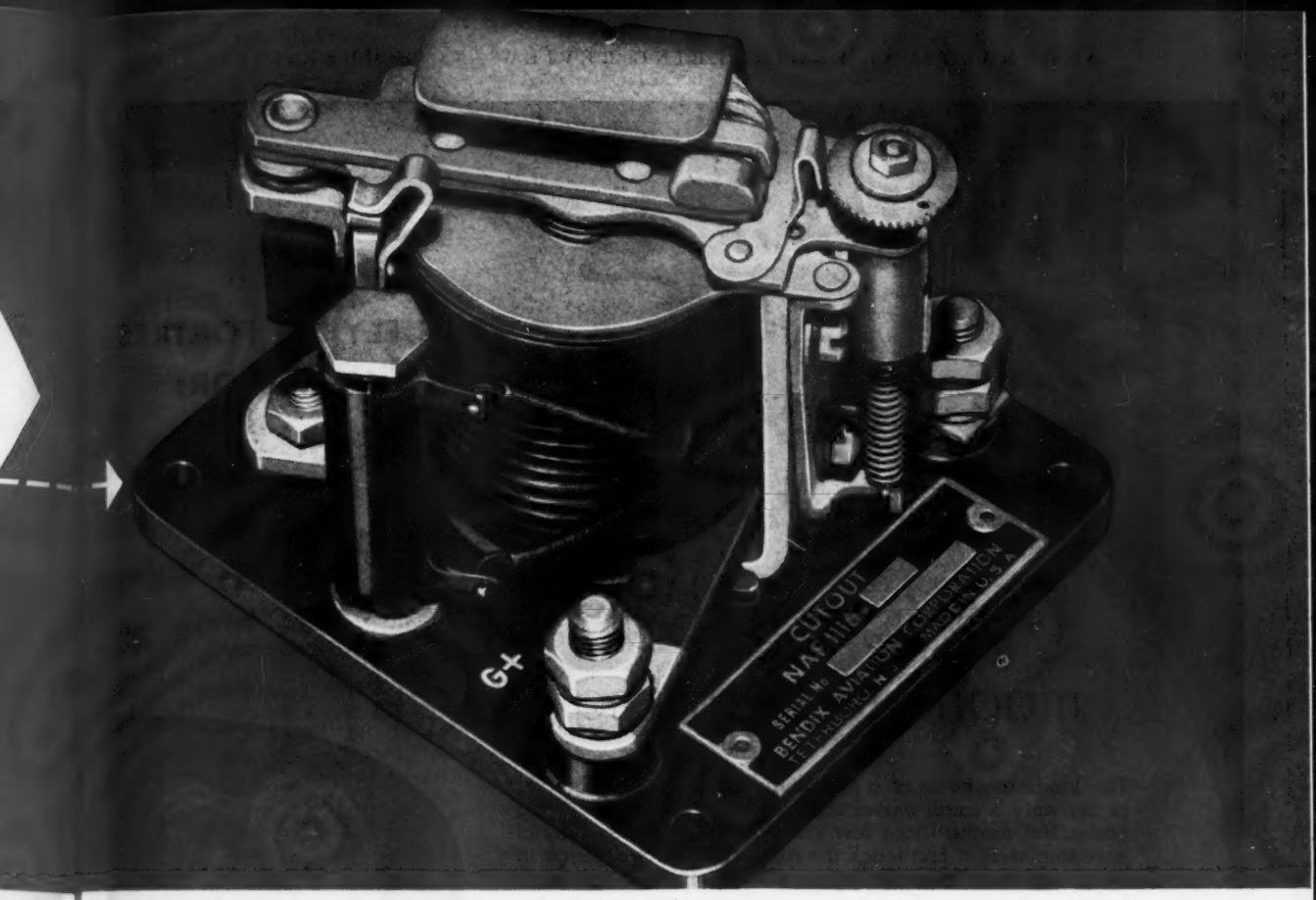

DESIGN CHECK CHART FOR ECLIPSE REVERSE CURRENT CUTOUTS

APPLICATION:

- Eclipse Reverse Current Cutouts are designed to prevent the reverse flow of current to generators in aircraft power systems utilizing batteries and generators as a power source.
- Properly installed in the Aircraft Power Supply System, they provide a compact, lightweight means of automatically disconnecting generators from electrical systems when generator voltage drops below system voltage.

PERFORMANCE:

- Eclipse Reverse Current Cutouts automatically open on reverse flow of current★ from battery to generator when generator output voltage drops below system voltage. They also operate as generator automatic main switches.

Eclipse Type	Current-Amperes	Volts D.C.	Setting Volts	*Opening Reverse Current-Amperes	Weight Lbs.	Dimensions—Inches Width	Length	Height
350	25	15	13.5+.1	3	.82	2 1⅜6	2 1⅜6	2¼
352	100	15	13.5+.1	5	1.63	3¼	3¾	2⅝
688	25	30	26.7+.1	3	.82	2 1⅜6	2 1⅜6	2¼
665	100	30	26.7+.1	5	1.63	3¼	3¾	2⅝

DESIGN FEATURES:

- Changes in Cutout temperature have minimum effect on operation.
- Operate satisfactorily in any mounting position when adjusted in that position.
- Armature leads on Types 352 and 665 are shielded to prevent change in Cutout setting through handling.
- Silver alloy contacts have long life and low voltage drop.
- Adjustment knob is conveniently accessible and automatically locked.
- Lightweight and compact.

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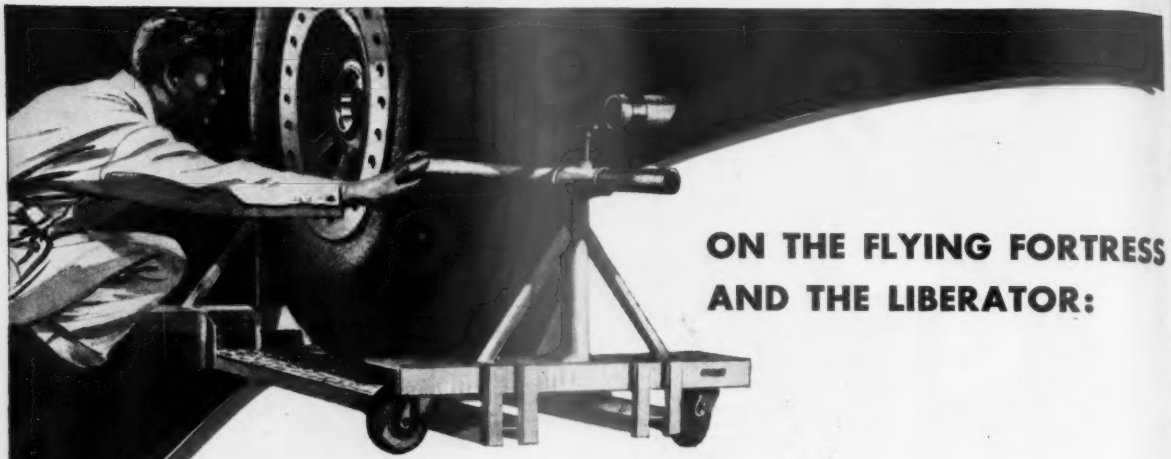

ON THE FLYING FORTRESS AND THE LIBERATOR:

Weight-saving magnesium landing wheels

The landing wheels of a four-engine bomber are actually in use only a small percentage of the aircraft's total flying hours. But during those few crucial seconds when tons of speeding weight first touch the runway, those wheels go to work, and they must do their work dependably and well. In the air, when the same wheels become mere lazy weight, extreme lightness is a matter of critical importance.

Because magnesium is the lightest of all structural metals and because it is strong and durable, the main landing wheels of the Boeing B-17 Flying Fortress and the Consolidated B-24 Liberator logically are constructed of Dowmetal Magnesium Alloy. So are many other parts of these highly efficient aircraft.

Hayes Industries, Inc., of Jackson, Michigan, one of the country's largest manufacturers of aircraft wheels, uses Dowmetal in this sand-cast 56-inch landing wheel for heavy bombers.

Magnesium merits consideration in any industrial project where metal is put in motion—in rail and highway transportation as well as in the air—in the moving parts of machinery—in portable, hand- and power-operated tools and equipment. As America's pioneer in the development of magnesium, and as its major producer, Dow also maintains research and production facilities for converting this key metal into permanent mold, sand, and die castings; extrusions; forgings; sheet, plate and strip; and fabricated assemblies. Inquiries will receive prompt attention.

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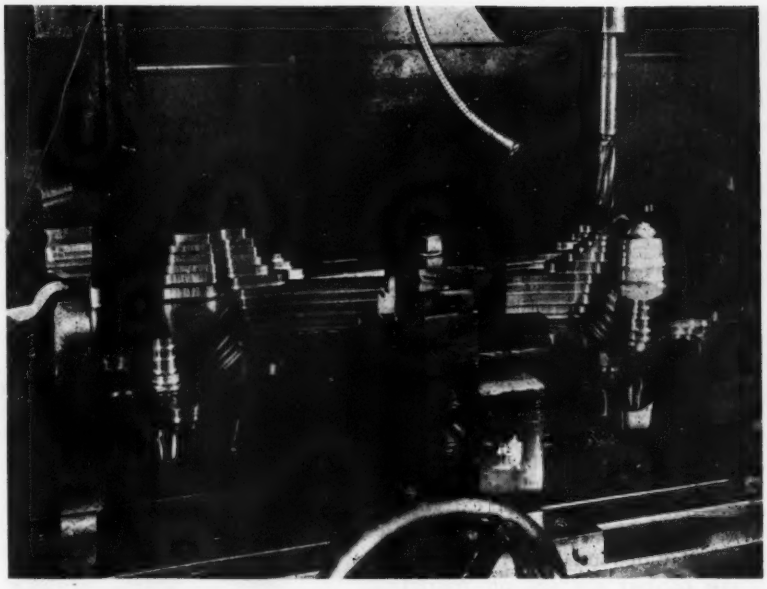
that: (1) allowable draft must be specified; (2) consistent corner and fillet radii must be employed; (3) legend and part number locations must be carefully chosen; (4) machining allowance must be provided; (5) ejector pin marks must be allowed for; and (6) tolerances must be carefully selected and wisely applied.

It is noted that drawings for forgings require special care to avoid delays and expense caused by changes. Separate drawings are recommended for the rough forging and for the machined forging, because the greater drafting time is more than offset by the saving resulting from the elimination of errors and wasted materials and labor. The seven fundamental considerations for preparing a forging drawing are outlined and explained. *Western Flying*, September, 1944, pages 64, 66, 68, 70, 7 illus.

Using Negative Rake Tools in Aircraft-Parts Production. J. Q. Holmes. The machining of the chrome-molybdenum and chrome-nickel-molybdenum steels used by the Eastern Aircraft Division of General Motors in manufacture of parts for folding-wing fighter planes is discussed. An investigation of negative-rake cutting conducted in 1942, which disclosed the possibilities of this method and the high cutting speeds that could be used, is outlined. How the new process was put into operation at the plant is described. It is stated that 30 jobs are now running with negative-rake tools. Sections of the article deal with milling operations, operating precautions that must be taken, the tooth load and number of teeth, and power requirements. *Mechanical Engineering*, September, 1944, pages 576–580, 12 illus.

"After Glow" Technique for Template Reproduction. Richard O'Connor. An account is given of the X-ray afterglow technique employed by North American Aviation to speed the reproduction of master layouts for patterns and templates used in Mustang fighter production. It is explained that a 20-ft.-high industrial X-ray unit, which reproduces 5 by 12 ft. steel templates, is the core of the reproduction method. Used in conjunction with the process is an 8-ton enlarging and reducing camera for working shrink plates. This camera also makes it possible to produce quarter-size templates for wind-tunnel models in a few hours. *Industrial Aviation*, September, 1944, pages 6, 66, 67, 100, 6 illus.

Designing Rubber Press Tools. J. Albin. A two-part article discusses the construction of rubber press tools for the forming of sheet in the hydropress. In Part I it is shown that accurate forming can be accomplished if consideration is given to the dual action of the frictional and fluid properties of the rubber when under compression. The writer describes how an analysis of rubber-pad action has made it possible to establish design standards, and to develop unusual form blocks and other rubber press tools. The elimination of hand finishing is illustrated by novel uses of dams, undercuts, punches, and other tool elements.



Finish milling the reverse side of a wing hinge at the Columbus plant of the Curtiss-Wright Corporation. This method was chosen instead of forging dies to provide wing hinges of new design for experimental testing.

Part II describes applications of rubber press tools for forming concave, convex, and reverse flanges, joggles, and some new difficult shapes. Particulars are given about certain drawing operations on sheet aluminum previously considered beyond the capacity of the hydropress. The data presented are from the Eastern Aircraft Division of the General Motors Corporation. *The Iron Age*, September 14, 1944, pages 50–57, 19 illus.; September 21, 1944, pages 59–66, 23 illus.; "The Use of Rubber in Conjunction with Press Tools," *Machinery*, September, 1944, pages 172–176, 10 illus.

Magnetic Indicator Speeds Rivet "Cleanup" Job. This is an article on a device for locating defective rivets during the fabrication of an aircraft assembly or subassembly. Developed by the Curtiss-Wright Corporation, the device consists of a magnetized rod and indicator. *Aero Digest*, September 1, 1944, page 104, 3 illus.

The Production of Aircraft Stampings. J. A. Oates. The second of two articles reviewing the manufacturing methods and laboratory control techniques of High Duty Alloys, Ltd., in their production of stampings for the aircraft industry. In this concluding article the layout of a typical High Duty Alloys factory, its furnace design, and its equipment are described in detail. Features of the company's production methods are also particularized in an account of how crankcase sections are manufactured for a radial engine. *Aircraft Production*, September, 1944, pages 413–424, 28 illus.

Reynolds Aluminum Fabrication. Joseph Geschelin. This article deals particularly with the production of finished aluminum in a plant of the Reynolds Metals Company. It is a fully integrated plant, stated to be the only plant in this country carrying out the complete process of refining the bauxite; the making of aluminum sheet, bars, rods, and extruded shapes; and the conversion of these into finished parts ready for assembly into air frames. Various production operations and equipment are illustrated. *Automotive and Aviation Industries*, September 15, 1944, pages 38–40, 82, 84, 86, 7 illus.

The Secret of the Stinger's Wing. Chester S. Ricker. A series of photographs with explanatory captions depicts the equipment and manufacturing techniques used in the production of the Mosquito wing. The fixtures, machinery, and procedures surveyed are those of the Massey-Harris Company, Ltd. *Wings*, October, 1944, pages 1238–1244, 26 illus.

Statistical Quality Control. Vernon R. Grom and Martin A. Brumbaugh. Techniques established by the Curtiss-Wright Corporation in its approach to the problems of statistical quality control are outlined. After defining what statistical quality control is, the writers record the organizational setup of the Curtiss-Wright quality-control program. Brief details are given on the functions of the Statistical Quality Control, the Materials Review, and the Corrective Action sections. These are followed by more complete descriptions of the company's inspection and control-chart procedures at three levels of operation: receiving, fabrication, and assembly. In describing how methods of quality control analysis are applied to specific problems, the writers give particular attention to the means that are em-

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ployed for reducing faults that occur in assembly operations. *Aero Digest*, September 15, 1944, pages 110–112, 136, 138, 143, 6 illus.

Methods of Using Dowel-Pins in Precision Tool Design. Eugene E. James. The importance of using correct dowling methods in die making, where tolerances often are specified in thousandths of an inch, is emphasized. The writer discusses toolroom dowling practice and describes how dowel pins are designated. Information is given about applications of semiblind and blind dowel pins, and the number of dowel pins required. *Machinery*, September, 1944, pages 186–188, 11 illus.

Propellers

Airscrews as Landing Brakes. A. Von der Muehll. This article, which is a translation from *Flugwehr und Technik*, reviews the braking results obtained with a single-engined fighter equipped with a V. P. Escher Wyss landing-brake propeller. Figures quoted reveal that the ground run, with wheel brakes alone, amounted to 61 per cent of that without braking of any description. By means of the propeller brake alone, this distance was reduced to 28 per cent of the original value.

It is noted that these figures show that propeller braking made it possible to reduce the landing distance to less than one-third of that required for a normal landing with energetic use of the wheel brakes. The technical assumptions for this method of braking, as well as its possible effect on the development of modern aircraft, are discussed in sections dealing with aerodynamic braking with a propeller, the propeller as a diving brake, the propeller as a landing brake, the speed of adjustment and power required, and landing brake operations with the Escher Wyss variable-pitch propeller. *Aircraft Engineering*, August, 1944, pages 216–218, 4 illus.

Radio

Correct Procedures for Aircraft Antenna Installations. This is a summary of the most important things to remember in connection with antenna layouts and installation in nonmilitary aircraft of the single-engined type. The proper procedures are illustrated in "do-and-don't" charts. *Aviation Maintenance*, September, 1944, pages 74–86, 134, 137, 7 illus.

Reaction Propulsion

Improved JP Systems Under Way; Gas Turbines to Open New Power. A brief article states that United States research on jet propulsion has been stepped up to the point where several systems are under development. Indications are that the Bell P-59A already has been superseded in speed and performance by at least one plane. It is believed that the

P-59A will now be used mainly for training purposes.

The trend in engineering opinions regarding the gas turbine is discussed, and the problem of finding suitable materials for gas turbines and jet propulsion units is considered. Advantages claimed for the gas turbine are listed. In comparing the reciprocating gasoline engine with the gas turbine, it is noted that in the latter the compression and expansion processes are not performed in the same chamber. As a result, the expansion ratio is not limited by the compression ratio, and expansion may be carried out to atmospheric pressure. Thus, in the perfect turbine the full energies of the combustion mixture could be utilized for work. *Aviation News*, September 11, 1944, pages 11, 12, 2 illus.

Resonance Reaction Drives as Used in Flying Robot Bombs. Max M. Munk. As indicated by recent news releases, the writer reports that flying bombs are driven by resonance-reaction engines instead of genuine rocket engines. He explains the principle of resonance-reaction and its application to rocket bombs. Demonstrating the limitations of the regular rocket engine for the flying bomb, he analyzes the advantages of using the resonance-reaction drive which, supplied with the necessary gasoline, does not require stored oxygen but takes the combustion air from the atmosphere. The lesser efficiency of the resonance-reaction engine as compared with the efficiency of conventional engines is also investigated.

The technical difficulties encountered in developing a suitable propulsion system for the flying bomb is advanced as the reason why the Germans have waited until the last stages of the war to launch this new weapon. It is believed that the obtaining of greater range for the flying bomb is dependent upon the improvement of the resonance engine and, because of the natural barriers to that attainment, the bombing of New York from European bases is still a remote danger. *Aero Digest*, September 1, 1944, pages 54, 55, 130, 4 illus.

Gas Turbine Plant May Bring Radical Changes in Plane Design. Various applications of gas-turbine plants to aircraft which may be expected to be tried before long are discussed. Consideration is given to the case of large, multiengined aircraft where a central gas-generation plant could supply a number of turbines, each driving propellers. It is stated that combustion gases from a generator located in the fuselage could be ducted to compact turbines "buried" in the wings.

The advantage that would be obtained with such an arrangement are outlined. Open thermal cycle turbine plants for both shaft drive and jet propulsion are discussed. Consideration is given to air-compressor drive. It is noted that gas turbines for jet engines and those designed for propeller-shaft drive are inherently dissimilar. In the former, the turbine's sole function is to drive the compressor, and it should absorb the least possible energy from the exhaust gases to do it. In the propeller arrangement, the turbine's main function is to deliver mechanical power to the shaft and the least possible energy should be given up to drive the air compressor. It is suggested that a four-engined aircraft might be provided with two turbine-propeller plants and two jet plants so that each type could be used at the altitude where it would provide most efficient propulsion. *Aviation News*, October 2, 1944, page 14.

Reconversion

Reconversion. Donald Douglas. An outline is given by the President of Douglas Aircraft Company, Inc., of a plan for converting the aviation industry to normal peacetime production. It is stated that industry alone cannot play the deciding role in reconversion. First, the Government must guide, shape, and approve a master blueprint from which a sound and constructive postwar program can be built. Then industry must suggest ways for developing the program. Stressing his company's willingness to serve the nation in wartime without regard to profit, the writer notes the obligation of Government authority to aid in orderly restoration to normal conditions after the war, with removal of restrictions. He suggests gradual termination of contracts and employment readjustments and then outlines his hopes and plans for peacetime business. *Air Trails*, November, 1944, pages 23, 96–99, 1 illus.

Stress Analysis

Efficiency of Lateral Stiffeners in Panels. Adam Zahorski. This article discusses the "grid" analysis of flat panels reinforced by longitudinal and lateral stiffeners and subjected to the longitudinal compressive forces. Diagrams for the design of lateral stiffeners in various combinations are included. *Journal of the Aeronautical Sciences*, October, 1944, pages 299–306, 19 illus.

An Iterative Method for Determining Dynamic Deflections and Frequencies. N. A. Boukidis and R. J. Ruggiero. A solution to the problem of finding the natural modes and frequencies of vibration of a linear elastic system is given. Particular emphasis is placed on the determination of the

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INSPECTION DATA . . . Gravity, °A.P.I., 34.4 . . . Flash, Degrees F, 230 . . . Pour Point, degrees F—70 . . . Saybolt Univ. Vis., Secs. at 210°F, 44.3; at 100°F, 81.3; at 40°F, 207; at 0°F, 601; at—40°F, 3031 . . . Viscosity Index, 207.

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higher modes of oscillation—i.e., modes other than the fundamental. It is found that the quantities needed to obtain the higher modes are available after the fundamental frequency and mode of vibration have been determined. This results in a saving of considerable labor.

The theory is developed in some detail after which it is applied to the calculation of the bending oscillations of the wing of a twin-engined monoplane. The necessary steps in such a procedure are summarized in a form adapted to numerical computation. This makes the process largely independent of reference to the theory previously developed. *Journal of the Aeronautical Sciences*, October, 1944, pages 319–328, 3 illus.

Stress Analysis of Open Cylindrical Membranes. Leon Beskin. It is known that axial stresses in open cylindrical membranes are not completely defined by the axial load and the bending moments in two directions and that supplementary stresses may exist, which are generally ascribed to torque.

Those stresses, in the case of conventional approximations, can generally be neglected for closed membranes. They cannot be neglected for open membranes since they are necessary to insure the local equilibrium under general loading. As those stresses may exist even when no torque is applied, in the same manner as stresses due to bending exist in pure bending (without shear), a method of determination of the distribution of axial stresses which would generalize the formula for pure bending is developed. Those axial stresses can be combined by addition (superposition) with the stresses due to axial load and bending.

In order to obtain this result a new mechanical concept must be introduced. This concept is called a bicouple and it has the same relationship with the warping curvature as a couple has with the conventional curvature.

Under nonuniform warping without bending or axial load, the axial stresses constitute a bicouple. In the case of uniform warping curvature the distribution of axial stresses is completely defined by the value of the bimoment.

In the case of symmetrical profiles, the analogy with bending can easily be developed by introducing a "conjugate beam" placed in the plane of symmetry, the center of gravity of which is the shear center of the given section, and the moment of inertia of which is equal to I_0. For unsymmetrical profiles, a conjugate beam can also be introduced, but its location has no definite relationship with the given section and it has a less important physical significance than in the case of symmetrical profiles.

The concept of the bicouple and the relations which are its consequences are "true" in the sense of the theory of elasticity provided the membrane has no thickness and deflections are infinitely small. The extension of the theory to the condition of a membrane under applied end torque is similar to the extension of pure bending distribution to cantilevers under applied transversal end load. A uniform warping curvature due to constant shear distribution does not affect the distribution of axial stresses. Those stresses still constitute a bicouple but, as they are proportional to the distance to the end section, the bicouple is proportional to the product of the torque by the distance to the end section, and the definition of a bicouple is such that the two quantities are equal. This product is called the bimoment of the torque in respect to the section and in any section the bicouple of the axial loads is equal to the bimoment of the torque.

The relationship between bimoment and torque can be conventionally extended to any loading condition, the torque being the opposite of the derivative of the bimoment taken along the axis of the membrane, but for an arbitrary loading the relation between distribution of stress and bicouple is not absolutely correct; however, it can be applied in the same manner as the formula for pure bending is applied for any load distribution in conventional stress analysis. *Journal of the Aeronautical Sciences*, October, 1944, pages 343–355, 11 illus.

Flexural Strength in the Plastic Range of Rectangular Magnesium Extrusions. F. A. Rappleyea and E. J. Eastman. A problem exists in the use of magnesium alloys in aircraft of determining the resisting moment in bending. Special methods and theories have to be used in order to predict these values because of the lower yield strength of wrought magnesium alloys in compression as compared to tension. The standard classic formula is not applicable, and some other formula is necessary. Experimental tests were made which agreed fairly well with a theoretical formula. The tests were made on various magnesium alloys of several different sizes. The deviations of experimental results from theory were not excessive. *Journal of the Aerotical Sciences*, October, 1944, pages 373–377, 8 illus.

Corrections for Lengths of Columns Tested Between Knife Edges. William R. Osgood. When a column tested between knife edges is supported on carriers between the knife edges and the ends of the column, the length of the column is taken as the distance between knife edges. When this is done, only a small error is introduced if the column specimen is long relative to the distance between knife edges, but the error may amount to several per cent for short columns. There are two practical ways of avoiding this error in tests made under eccentrically applied loads when it is desired to obtain column curves corresponding to a series of constant eccentricities. These methods of making corrections are discussed. *Journal of the Aeronautical Sciences*, October, 1944, pages 378–380, 3 illus.

Buckling Loads of Beams or Plates on Continuous Supports. Edward Saibel. A method is developed for finding the buckling loads of beams or plates over continuous rigid or elastic supports. These loads are found as the roots of characteristic equations that are developed in terms of the known characteristic modes of buckling and corresponding characteristic buckling loads of the beam or plate without the rigid or elastic supports. The method is an application of the direct method of the Calculus of Variations and consists of minimizing the potential energy of the system subject to the constraints that are the inner supports, rigid or elastic.

The object of this paper is to develop a method whereby the buckling loads of beams or plates, having simply supported, fixed, or free boundaries, and subject to inner constraints in the form of intermediate rigid or elastic supports, may readily be calculated. These buckling loads are the roots of the characteristic equations that arise from the condition that the potential energy of the system shall be a minimum subject to the constraints. By developing the buckled shape of the system as a Generalized Fourier Series in terms of the characteristic (or eigen) functions of the unrestrained system, in many cases known or easily found, it is possible to express the potential energy in a simple and compact form from which there is no difficulty in deriving the characteristic equation. Few terms of these equations need be used to obtain reasonably accurate results in most problems. The beam has been previously solved, but the present treatment will be found to have advantages in some cases over the existing method. This is particularly evident if the beam is uniform. In the case of the plate results believed to be new are found. *Journal of the Aeronautical Sciences*, October, 1944, pages 399–403.

Solution by Relaxation Methods of Plane Potential Problems with Mixed Boundary Conditions. L. Fox. In this paper the writer obtains solutions of Laplace's equation with boundary condition involving either the normal gradient only or both the boundary value and the normal gradient. It is explained that the need for a technique for problems of this kind has arisen in recent developments of the relaxation method. Two problems are solved, both having a known analytical solution, and good results are obtained in each case. The method used is independent of the analogy of tensioned nets and can be applied without modification to problems for which analogies may be difficult to use. *Quarterly of Applied Mathematics*, October, 1944, pages 251–257, 9 illus.

Rigidity of Wing and Tail Surfaces. J. L. Beilschmidt. An article written for students and not intended to contribute anything new to the science of aeronautics. It consists in the main of a survey of present-day methods of calculating and measuring the wing and tailplane stiffness with the object of assessing the aerodynamic-elastic distortion characteristics. *Aircraft*

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Engineering, August, 1944, pages 228–234, 19 illus.

The True Stress-Strain Tension Test—Its Role in Modern Materials Testing. Part II. C. W. MacGregor. The writer reports the effects of various metallurgical conditions on the true stress-strain properties. He then describes the use of this form of test in connection with the metal-forming process and other materials-testing problems.

In a summary it is stated that the investigation shows that the tension test in its more rational form, where true stress and strain values are recorded, is quite useful in connection with the analysis of metal-forming processes, in correlating the results of notched-beam impact tests, fatigue tests, notched-bar tests, and combined stress tests with tension values. *Journal of the Franklin Institute*, September, 1944, pages 159–176, 11 illus.

General Solution of Two-Dimensional Problems of Elasticity. Leon Beskin. The solution of the general problem of elasticity given in this paper applies for a two-dimensional simply connected domain with an arbitrary boundary and given volume and boundary forces. Since the general problem for an indefinite plane with various nuclei of strain has been solved, it is possible to find a solution that would satisfy the differential equations of equilibrium inside the domain without satisfying the conditions at the boundary. Then, by superposition, it is possible to reduce the problem to that of volume forces equal to zero and given boundary forces. *Journal of Applied Physics*, July, 1944, pages 562–567, 4 illus.

Lateral Bending of Symmetrically Loaded Conical Discs. K. E. Bisshopp. Comparison of the solution for the rotating conical disc problem with the corresponding one for lateral bending shows that the basic differential equations involved, the expressions for the stress, are analogous. Previously described methods for obtaining solutions of the former problem in terms of hypergeometric functions are applicable to the latter problem. It is shown that the special type of hypergeometric differential equation associated with the lateral bending problem has solutions that give the stress coefficients with less labor than in the case of the rotating conical disc.

Stress coefficients have been arranged conveniently for numerical calculation of conical discs, which are component parts of a wide variety of engineering structures. The head of a large poppet valve provides a particular example where the principal stress member can be approximated by a system of incomplete conical discs. In order to illustrate an application of the theory, stress coefficients for conical discs subject to lateral bending, as well as for rotating conical discs, are used to estimate stress distributions in a steel valve head of a constant weight and various proportions. Since the coefficients are obtained from solutions of

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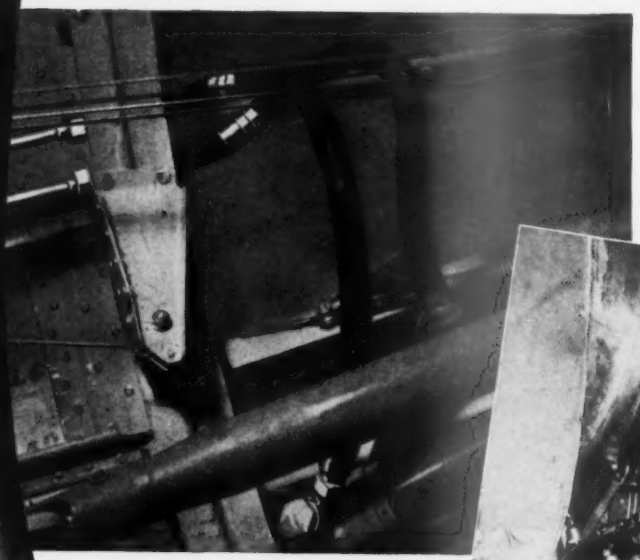
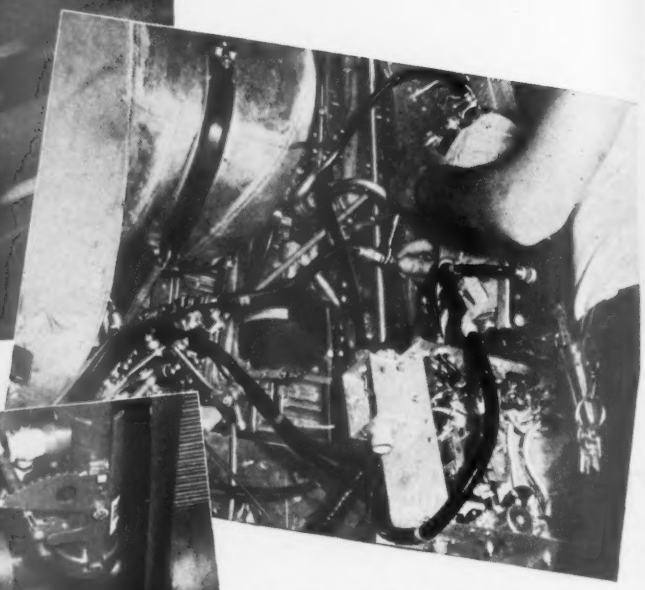


Flex-O-Tubes on the tail wheel actuating cylinder.



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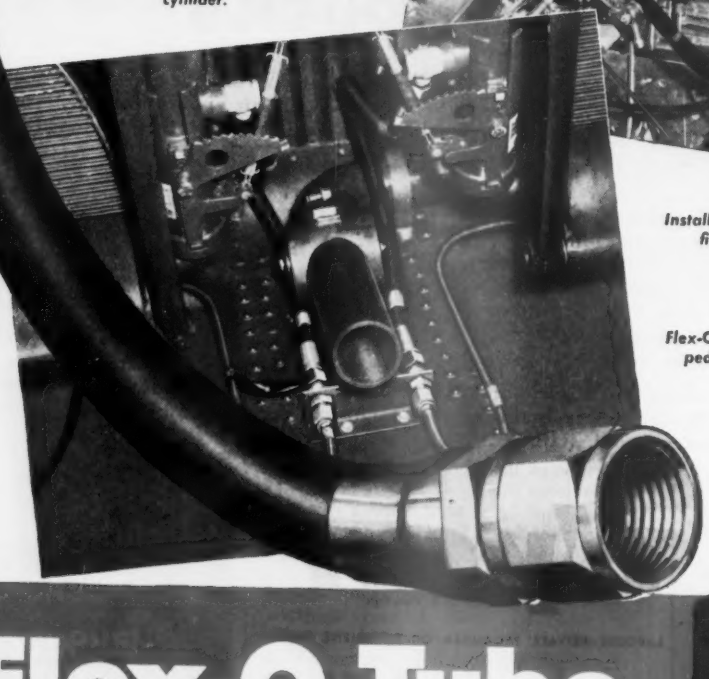

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differential equations for thin discs, the approximate method breaks down in the neighborhood of the valve stem. These limitations have little effect near the periphery, which makes it possible to calculate valve proportions corresponding to approximately uniform stress distribution throughout the head. A description of the illustrative example at the end of the paper explains the method of calculation in detail. *Quarterly of Applied Mathematics*, October, 1944, pages 205–217, 4 illus.

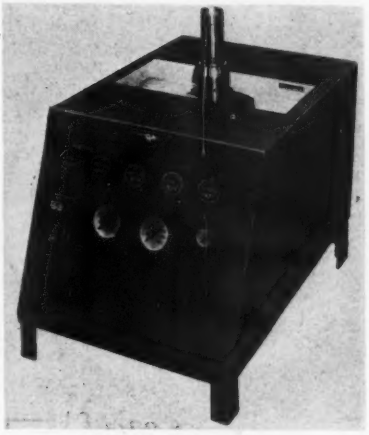
Theory of Membranes in Shape of Developable Surfaces. Leon Beskin. The theory of equilibrium developed in this paper is an application to developable surfaces of the general equations of equilibrium of membranes; such theory disregards local bending in the thickness of the membrane. The analysis deals with general developables, exclusive of cones and cylinders. *Journal of Applied Physics*, July, 1944, pages 547–561, 17 illus.

Superchargers

The Rotol Cabin Supercharger. A brief description is given of the Rotol Cabin Supercharger, of which a feature is the two spindles carrying two rotors that interact without actually touching each other or the aluminum casing. This provision is intended to solve the problem of keeping the cabin air free from oil contamination. The oil seals used in the solution of this problem are described, as well as another feature of the supercharger through which the air-delivery temperature increases with the altitude, thereby compensating for the drop in the air temperature outside the cabin. The blower maintains air pressures corresponding to 10,000 ft. when flying at altitude up to 40,000 ft. *The Aeroplane*, August 4, 1944, page 127, 1 illus.

Testing Equipment

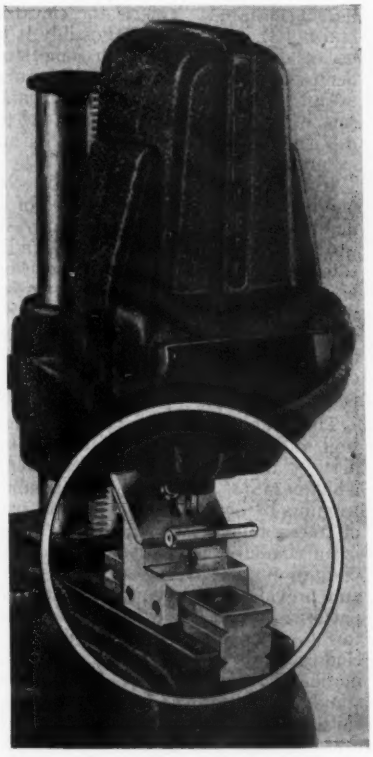
Role of the Thermal Conductivity Cell in Aircraft Instruments. Part II. Michael A. Picciano. In the second section of an article giving the theoretical considerations governing the operation of exhaust-gas analyzers, conduction and convection losses are discussed. The differences between the two processes are defined, convection being called a macroscopic phenomenon while conduction is microscopic. The variables concerned with natural and forced convection are explained, and a simplified expression is developed for application to losses in the hot-wire thermal-conductivity cell, as well as preliminary experimental determinations to show the accuracy of the mathematical computations. The writer discusses at length the applicability of the hot-wire anemometer in gas-analysis work, giving the equations upon which its operations are based. *Aero Digest*, September 15, 1944, pages 114, 115, 249, 251, 4 illus.



The Airplane Manufacturing & Supply Corporation's hydromatic propeller test stand for testing all types of Hamilton Standard hydromatic propellers.

Tools and Equipment

Bar Bucking Assemblies Speed Riveting. A description is given of a rivet-bucking assembly that may be wielded manually by a rivet bucker or may be set up in a jig or fixture frame so as to function automatically. It is stated that this assembly, which was invented by a Consolidated Vultee employee, has resulted in materials saving, improved workmanship, and increased production. *The Iron Age*, September 7, 1944, pages 82, 83, 5 illus.



A new ball-point accessory for Sheffield visual gauges permits the rapid production checking of pitch diameter on the threaded parts. Accuracy is said to be comparable for practical purposes to that of the three-wire method.

Section Forming and Bending. The construction, processing methods, and advantages of the Benfold machine are described. Developed by the Fairey Aviation Company, Ltd., this machine forms and bends aircraft components in one operation. It is capable of producing direct from the flat strip or blank many of the reinforcing parts used in stressed-skin construction, such as rib booms, fuselage-frame flanges and stiffeners, etc. When produced by the Benfold machine, these parts are ready for assembly without further manipulation.

The machine is described as being, basically, a flexible draw-bench. Normal draw-bench technique is used to obtain the actual section form. However, instead of being fixed rigidly, as in normal practice, the dies are flexibly mounted in order to conform to the curvature of the required bend. The controlling member in the sequence of operations is the former bar, which not only constitutes the means of feeding the material through the dies but gives internal support to the section during the drawing operation and, by its set or curvature, controls the amount of bend given to the drawn section. *Aircraft Production*, September, 1944, pages 411, 412, 6 illus.

Cleaning Machines for Aviation Reconditioning. R. W. Mitchell. The writer discusses machines and methods used for the removal of oily dirt, sludge, carbonized oil, and other deposits from aircraft parts and assemblies that are being reconditioned. Solvents for cleaning aircraft-engine pistons and other parts are described, and the requirements for cleaning machines are outlined. *Aviation Maintenance*, September, 1944, pages 62, 130, 132, 1 illus.

Designing Tools to Meet Labor Shortage. J. S. Haldeman. Tools and methods designed to counteract labor shortages are described. It is noted that these tools have enabled Lockheed Aircraft Corporation to maintain its production schedules despite a scarcity of skilled help. Some of the tools described include a machine for the automatic beveling of engine cowlings; a bend-degree dial and a plane-of-bend indicator for application to a tube bender; a special horn press designed to punch holes for fittings in electrical conduit boxes, and a resistance normalizing fixture which combines sizing, normalizing, and splice-welding operations on an engine-mount ring. Others are a hand-operated squeezer for installing tack grommets; a portable squeezer with a special unit for punching plate-nut holes two at a time; a wrap forming machine especially equipped for bar-forming operations; and a beam-type punching and riveting machine redesigned to accommodate large fuselage panels. Information is given about how these devices are designed, made, and used. *Ma-*

chinery, September, 1944, pages 147–157, 21 illus.

Torque Wrenches. J. Joyce. The importance of training mechanics to tighten properly aircraft bolts, nuts, studs, and screws is emphasized. It is pointed out that every bolt has a definite point at which it will function to the best advantage. If proper tension is attained with every bolt in an assembly, the bolt will remain secure, will not vibrate loose, and will not impose any strain upon the component parts of the assembly to cause fracture, distortion, or other failure. Improper tension may cause shearing of the bolt, stripping of the thread, or warpage, distortion, or fracture in component parts. Torque wrenches are discussed, and eight simple rules governing the effective use of the torque wrench are listed. *Air Tech*, October, 1944, pages 36–38, 64, 9 illus.

Spar-Boom Milling. The Wadkin LZ6, a machine used for milling the spar-booms of the Avro Lancaster, is the subject of this article. Its construction, operation, and differences from its predecessor, the Wadkin LZ2, are described. Attention is called particularly to the adaptability of the LZ6 for carbide cutting alloys, its speed and feed range, electrical equipment, hydraulic-copying system, and fully automatic machining cycle. Methods of hydraulically clamping the fixtures and of removing swarf from the operating areas are noted. Principal dimensions of the miller are listed.

A traversing-head type of machine, the LZ6 is said to be similar in general design and layout to the LZ2, the first of the spar-boom millers devised by the Wadkins company to meet the Lancaster's special requirements. However, its spindle is driven by a 30–75-hp. motor in place of the 30-hp. unit fitted to the earlier machine, and the speed ranges are from 200 to 1,000 r.p.m., or from 400 to 2,000 r.p.m., infinitely variable, as compared with 75 to 500 or 150 to 1,000 r.p.m. Feeds are also greatly increased, and a maximum of 80 in. per min. can be obtained as against 36 in. per min. with the LZ2. *Aircraft Production*, September, 1944, pages 438–442; 9 illus.

Training

A New Approach to Flight Instruction Technique. John H. Geisse. A different method of teaching flight students the use of aircraft controls is proposed. Applicable to primary flight instruction only and not to acrobatics, the suggestions are based on the following major considerations: (1) Primary flight instruction should be on the effects of the controls and not on the performance of maneuvers. (2) Instruction in coordination of controls in the sense that two controls are used to accomplish the same maneuver should be eliminated. (3) Each control should be assigned a specific function for which it is to be used irrespective of the maneuver being performed. (4) No instruction should be given in the effect of controls on the position of the nose relative to the horizon. (5) There is one control, the misuse of which is primarily responsible for accidents, the use of which is difficult to teach, and on which instruction should be concentrated. This is the elevator and not the rudder. (6) Possibly it is useless to attempt to teach some students proper use of the rudder in a turn except by reference to instruments; such individuals should be taught not to use it in turns unless they have an instrument to guide them.

In discussing the recommended technique the writer suggests the use of a flight-path indicator actuated by a weather vane. This device would indicate angle of yaw and could be calibrated in air speed for a given gross weight, with its scale marked to show angle of attack for maximum glide, for best climb, and for most economical cruising. *Aviation*, September, 1944, pages 174, 175, 237–241, 2 illus.

The new Westinghouse gun-sight lamp makes it possible to fire more accurately against aircraft diving from the direction of the sun to attack. The new lamp provides light reported to be from eight to 30 times brighter than gun-sight lamps now in use with the same filament wattage. The brilliancy of the sight lines overcomes the glare of the sun.

The Tracer Trainer. The construction and operation of an aerial-gunnery training device is described. This equipment is for the ground training of aerial gunners in the use of tracer ammunition for gun sighting in air combat. It incorporates moving pictures of an attacking enemy airplane and provides simulations of the tracer patterns produced from a two-gun turret. Components of the trainer include a large cabinet unit, a 16-mm. motion-picture projector, a mirror stand, a collecting screen of black cloth, an air compressor, and a sound unit. Details are given about each component. *The Aeroplane*, August 11, 1944, page 155, 1 illus.

Getting the "Gravel Grinder's" Viewpoint. Some notes on the phase in a Marine Corps pilot's training when he is familiarized with the duties and life of a Marine in the ground forces. The two-weeks' ground defense course outlined is taken as part of the advanced training at the Marine Corps Air Station, Cherry Point, N.C. It serves to teach the pilots not only the need for perfect timing and coordination between air and ground forces but also how to take care of themselves in case of forced landing behind enemy lines. *Aviation*, September, 1944, page 179, 2 illus.

. . . And a Child Shall Fly Them. Irving Stone. An account of a flight-education experiment conducted by Pennsylvania State Teachers College in conjunction with Aircraft Services Consolidated. The experiment provided factual data on the ability of high-school students, as young as 14 years of age, to absorb flight instruction in addition to academic ground-school training. In an aviation course given to adults, as well as students of high-school and college age, the highest flight rating was attained by a boy of 14 who also achieved good results in other subjects.

It is reported how 13 students were enrolled in a 4-week summer-school aviation course, concurrent with a similar course for teachers. Eleven of these were boys and girls ranging from 14 to 16 years of age; the other two, 18 and 21, were college students. Training covered 10 hours of primary flight instruction in dual-control airplanes and 72 hours of combined ground-school instruction in avigation, meteorology, Civil Air Regulations, engines, and theory of flight.

Final grades of each student in the various subjects are tabulated. In addition to reporting these results, the article discusses the conclusions that may be derived from them. It comments upon the education readjustments that are indicated by this experiment and also mentions the possibilities of a lucrative market for operators which may be offered by secondary school flight instruction. *Aviation*, September, 1944, pages 110, 111, 279, 281, 283, 2 illus.

Warfare

Flying Dutchmen of Our Day. Henry Baerlein. A series of notes about the activities of Dutch air crews operating from England lauds the ability and heroism of the Hollanders. Information is included about the training and equipment of these men, their varied backgrounds, methods by which they escaped the Nazis and made their way to England, and the record of their compatriots in the Pacific combat areas. *The Aeroplane*, August 4, 1944, pages 128, 129, 7 illus.

Weight Control

Effects of C.G. on Speed. E. V. Argabright. The writer presents the results of studies and carefully conducted experiments that indicate that the effect of center of gravity location

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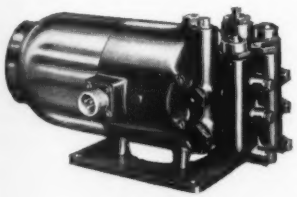

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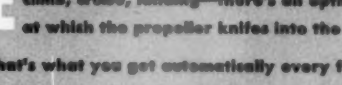

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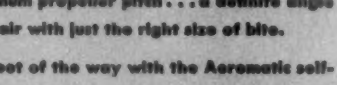

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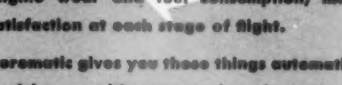

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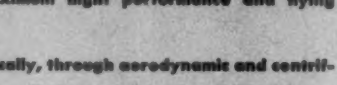

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on the speed and range of airplanes is negligible. Different explanations that have been advanced by advocates of the "optimum center of gravity" theory are discussed. In a summary of the discussion the writer states that a theoretical study indicates that small differences in speed are chargeable to center of gravity shift, but in careful flight tests of C-47, C-54, B-17, and B-24 airplanes no tendency toward an optimum center of gravity could be measured by any of the various test agencies. *Weight Engineering*, Fall, 1944, pages 14, 15, 17, 6 illus.

Weight Control in Aircraft Design and Production. Edward Bowyer. This is a general discussion by a British writer about the increasing attention that is being given to the subject of weight control. It is stated that aeronautical engineers are at last becoming truly weight conscious. A discussion of how the movement has progressed in the United States is included, and reference is made to the recent establishment of the Society of Aeronautical Weight Engineers.

It is stated that British aircraft manufacturers are paying close attention to the subject. Mention is made of the many conflicting design requirements for aircraft which have tended to obscure the need for keeping the weight down. It is noted that it is the duty of the weight engineer to see that the basic weight of a plane, once established, is not exceeded. Factors that result in the actual weight of an airplane exceeding the designed weight are enumerated. Methods of controlling the weight are discussed. *The Engineer*, August 19, 1944, pages 126, 127.

Locating Surface Actuating Points for Minimum Weight. B. L. Bogema. It is noted that efficient structural design requires that the actuating mechanism of a control surface be located at a point where the structural weight of the surface is a minimum. The writer derives an expression for locating this point which is applicable to any tab or control surface with an air load which is to be balanced at a single point located anywhere along its span. No attempt is made in this method to determine the locations for multiple-point actuation, since the deflections of the surface and of the actuating mechanism determine the portion of the total torsional moment which is resisted at each point. *Weight Engineering*, Fall, 1944, pages 38, 39, 2 illus.

C.G. . . . Adjusted in Flight. This article describes the use of a water-ballast system to adjust the center of gravity position on large transport aircraft in flight tests. With this system, which has been used on the Constellation, the center of gravity can be shifted during test flights to determine the practical center of gravity limits for various operating conditions and to aid in the investigation of the effect of various center of gravity movements on performance. *Weight Engineering*, Fall, 1944, pages 6, 7, 2 illus.

Welding

Welding Stainless Steel. With particular reference to exhaust manifolds, this article is concerned with the gas welding of stainless steel. It contains advice about the influence of welding heat, flame adjustment, fitting of the joint, the composition of the welding flux, and the accidental presence of zinc particles in obtaining a gas-welded stainless-steel component that does not buckle or warp and in which no intergranular corrosion occurs. Relative to flame conditions, it is stated that the flame should be as small as possible, supplying just sufficient heat to produce good fusion. The use of a flux of closely controlled particle size mixed with methanol is reported to have given satisfactory results. *Aircraft Production*, September, 1944, page 429.

Factory Preweld Cleaning of 24-ST Alclad and 61-SW Aluminum Alloys with Hydrofluosilicic Acid Solution. G. W. Scott, Jr., R. V. Ingram, and A. A. Burr. An extensive report of work carried out at the Armstrong Cork Company with hydrofluosilicic acid as a preweld cleaner for 24-ST Alclad and 61-SW aluminum alloys. The work extended over a period of about 6 months and resulted in the development of a procedure for the satisfactory use of a 1.18 per cent by weight solution of hydrofluosilicic acid with 0.1 per cent by weight of a wetting agent (Nacconal NR) as a preweld cleaner for 24-ST aluminum alloy. Results are summarized in charts and tables. *The Welding Journal*, September, 1944, pages 443-s–453-s, 18 illus.

Design Data for Spot Welds in Aluminum Alloy Sheets. James Ralston. The writer discusses welding principles and basic considerations governing the design of spot-welded aircraft parts made of aluminum-alloy sheets. He also presents data referring to the weldability of different aluminum alloys, the mechanical properties of spot-welded joints, gauge combinations, spot spacing, edge distances, and surface preparation. *Product Engineering*, September, 1944, pages 608–611, 5 illus.

Surface Preparation for Spot Welding Aluminum. S. G. Thornbury. In this article the writer first outlines the variables that affect the weld strength of joints and then discusses one of the most important of these factors—namely, the preparation of the aluminum surface for spot welding. It is noted that the primary function of surface treatment prior to spot welding is to produce a consistent resistance value to the flow of electrical current, preferably a low value. Consideration is given to the removal of the oxide film, the measuring of surface resistance, and etching requirements. Information is given about Vulc-Etch, an etchant formulated through cooperative research conducted by Turco Products and Consolidated Vultee Aircraft Corporation. It is stated that Vulco-Etch substantially meets all aluminum spot-welding requirements. It is explained that this etchant works on the principle of removing the aluminum oxide while minimizing the reaction with the underlying metal, thereby also minimizing the deposit of corrosion-promoting elements which may result from such reaction. The processing sequence used by Consolidated Vultee is described. *The Iron Age*, September 28, 1944, pages 46–49, 4 illus.

The Surface Treatment at Room Temperature of Aluminum Alloys for Spot Welding. W. F. Hess, R. A. Wyant, and B. L. Averbach. This is the third of a series of reports dealing with the surface treatment of aluminum alloys prior to spot welding. It is primarily devoted to investigations of solutions that operate at room temperature.

The report describes the development of a solution (No. 14) which is stated to have a number of advantages over other solutions for the surface preparation of Alclad 24S-T. Numerous charts and tables summarize the information. *The Welding Journal*, September, 1944, pages 417-s–434-s, 37 illus.

Resistance Welding in Aircraft. O. A. Perry and H. D. Hager. The substance is given of a paper on applications of resistance welding in aircraft fabrication, presented before the American Welding Society. The writers describe how Douglas Aircraft Company has speeded production by developing multiple spot welders for the tack assembly of stainless steel ammunition boxes and chutes, and an index spot welder for landing-flap deflectors. Information is also given about the development of collet-type dies for the concentric alignment of tubing for flash welding. *The Iron Age*, August 17, 1944, pages 66–71, 11 illus.

Miscellaneous

Roots of Frequency Equations. R. G. Manley. Using the "escalator" method of solving frequency equations, developed by Morris and Head, together with the natural extension of a lemma by Professor Temple, the writer presents simple proofs of the following two important theorems:

(1) A system with n degrees of vibrational freedom has n real distinct natural frequencies. (2) If an additional restraint is imposed on the system, the $(n - 1)$ natural frequencies of the resulting system separate the n natural frequencies of the original system. It is noted that the proofs usually given are complicated, and also that the second theorem is of particular importance in the numerical calculation of the impedance properties of propellers. *Aircraft Engineering*, July, 1944, page 203.

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Government Publications

Army Air Forces

The Air Technical Service Command, with headquarters at Wright Field, Ohio, is the consolidation of the former Matériel Command and the Air Service Command. Lt. Gen. William S. Knudsen is Director and Major Gen. Bennett E. Meyers is Deputy Director. The Air Technical Service Command is responsible for the design, engineering, procurement, production, inspection, maintenance, and supply of all airplanes and equipment peculiar to the A.A.F. It is also charged with the job of readjustment of A.A.F. war contracts, keeping man power and facilities at work under the changing demands of the Air Forces on all fronts. To accomplish these missions, the Command is subdivided into "Engineering and Procurement" (Chief, Brig. Gen. K. B. Wolfe) and "Maintenance and Supply" (Chief, Major Gen. C. McMullen).

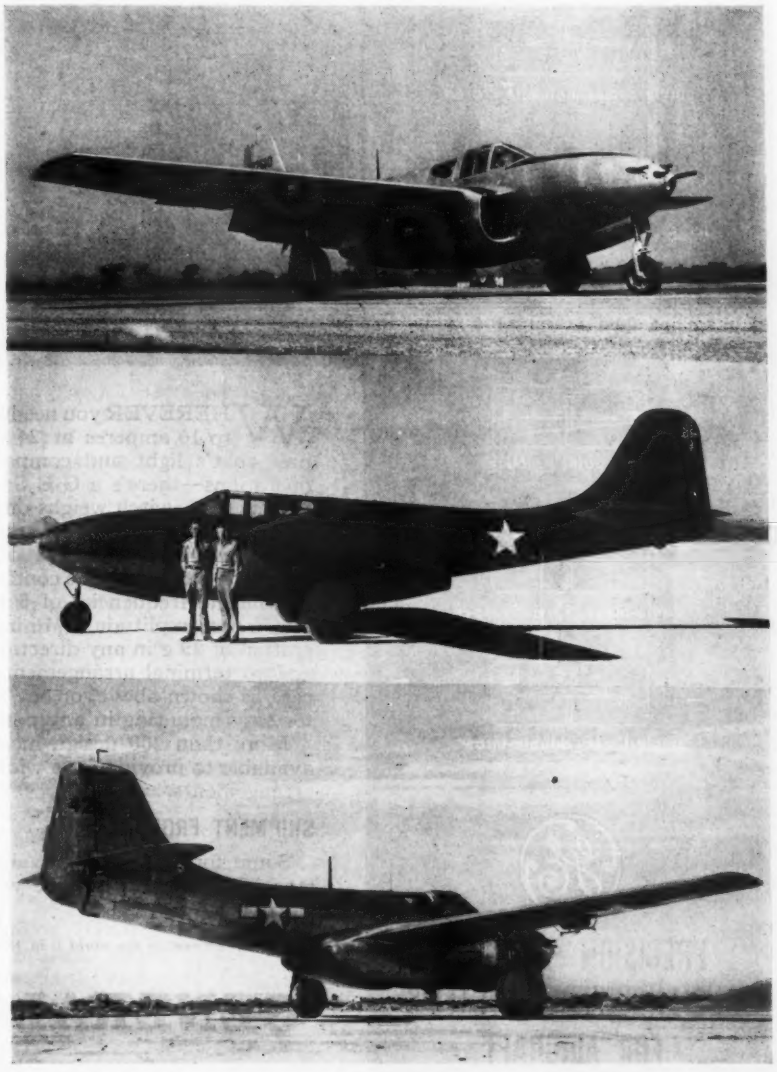
The three divisions under "Engineering and Procurement" are Engineering Division, Procurement Division, and Readjustment Division. The three divisions under "Maintenance and Supply" are Personnel and Base Services Division, Maintenance Division, and Supply Division.

The Engineering Division, of which the Chief is Brig. Gen. F. O. Carroll, is composed of the following laboratories and sections: Aero-Medical Laboratory, Chief, Lt. Col. W. R. Lovelace; Aircraft Laboratory, Chief, Col. P. H. Kemmer; Armament Laboratory, Chief, Col. R. E. Jarmon; Engineering Shops Laboratory, Chief, Lt. Col. J. W. Musser; Equipment Laboratory, Chief, Col. G. V. Holloman; Materials Laboratory, Chief, Mr. J. B. Johnson; Personal Equipment Laboratory, Chief, Col. John P. Fraim; Photographic Laboratory, Chief, Col. H. K. Baisley; Power Plant Laboratory, Acting Chief, Col. D. J. Keirn; Propeller Laboratory, Chief, Lt. Col. R. L. Jordan; Technical Data Laboratory, Chief, Lt. Col. J. M. Hayward; Flight Section, Chief, Col. E. K. Warburton; Aircraft Radio Laboratory, Chief, Col. H. R. Yeager.

Other principal divisions are as follows: Procurement Division, Chief, Brig. Gen. O. R. Cook; Readjustment Division, Chief, Col. E. V. Rawlings; Maintenance Division, Chief, Col. A. Boyd; Supply Division, Chief, Major Gen. Lester T. Miller; Personnel and Base Service Division, Chief, Brig. Gen. L. V. Beau.

Geographically, the Command is divided into six procurement districts so that close contact can be maintained with A.A.F. contractors. These districts, their locations and supervisors are: Eastern Procurement District, 67 Broad Street, New York 4, Col. D. L. Hutchins; Southeastern Procurement District, 86 Edgewood Avenue N.E., Atlanta 3, Ga., Col. R. W. Propst; Central Procurement District, 8505 W. Warren Avenue, Detroit 32, Col. A. H. Johnson; Midcentral Procurement District, 111 W. Jackson Boulevard, Chicago 4, Col. N. S. Talbott; Midwestern Procurement District, Municipal Airport, P.O. Box 117, Wichita 1, Kan., Brig. Gen. Ray G. Harris; Western Procurement District, 3636 Beverly Boulevard, Los Angeles 54, Brig. Gen. D. F. Stace.

Each procurement district maintains area offices, subarea offices, and resident representatives in the plants of A.A.F. contractors. *Air Technical Service Command.*



Three views of the Bell P-59 Airacomet jet-propelled fighter.

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for Lack of a SMALL Electric Switch

3 basic contact arrangements

single-circuit, normally open

single-circuit, normally closed

double-circuit; one normally open and one normally closed

And many special forms. For example:

three-point structure

single-break, normally open

single-break, double-throw

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WHEREVER you need a tiny contact mechanism in ratings up to 10 amperes at 24 volts d-c—an enclosed, self-contained unit that's light and compact, yet can withstand thousands of operations—there's a G-E Switchette to do the job.

This tiny switch weighs only 9 grams, and is suitable for use at altitudes up to 50,000 feet and in ambient temperatures from 200 F to −70 F. It's corrosion-proof—meets 50-hour salt-spray tests. It's vibration-resistant. The contacts will not chatter when subjected to mechanical frequencies of 5 to 55 cycles per second at 1/32-inch maximum amplitude (1/16-inch total travel), or to a linear acceleration of 25 g in any direction.

Two terminal arrangements are available—out the ends of the case as shown above, or out the top through the cover. This makes for easy mounting in any position.

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GENERAL ELECTRIC

These enclosed plunger-operated limit switches use standard Switchettes as the contact mechanism.

SAVE TIME

We also "*package*" SWITCHETTES in many widely used control devices

TIME savers as well as space savers—these adaptations and combinations of G-E Switchettes will fit right into your designs without requiring any modification. Developed by our engineers for use in the electric systems we build for many types of aircraft, these devices have been well tested in service and found to be the compact, lightweight solutions to problems of multicircuit control, pressure and temperature control, limit-switch applications, etc.

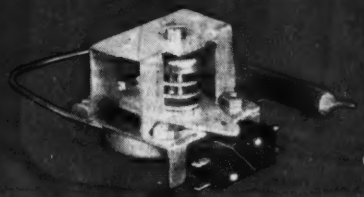
If You Don't See What You Want

Many more control devices, including push-button stations, timers, and other types of limit switches, are built around G-E Switchettes and are available for your use. If you don't see what you want here, ask for it. Chances are we have just the devices you need—if not, we may be able to modify existing designs to serve your purpose. Or, if you prefer to work Switchettes into your own designs, our engineers will be glad to help you.

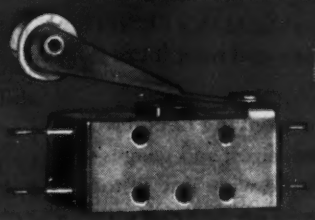
For your copy of our new catalog (GEA-3818B) which gives dimensions, ratings, and ordering directions for both standard and modified Switchettes, mail the coupon at the right or call our local office. *General Electric Company, Schenectady 5, New York.*

This multicircuit switch, made up of six Switchettes, controls as many as twelve circuits from a single location. Switches like this can be made up using from four to fourteen Switchettes.

Compact selector switches like this, operated by cams, are available to operate as many as fourteen Switchettes in any desired sequence.



A Switchette is used in this bellows-operated thermostat for automatic temperature control.



A simple roller actuator fits over the Switchette to make this tiny limit switch.

General Electric Company, Section B 676-150
Schenectady 5, New York

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	STAINLESS*	SAE 1025	SAE X-4130 NE-8630
3/8"	16 to 22	16 to 22	18 to 20
7/16"	16 to 22		18 to 22
1/2"	16 to 22	16 to 22	16 to 22
9/16"			16 to 22
5/8"	18 to 21	16 to 22	16 to 22
11/16"	16 to 21		
3/4"	14 to 20	16 to 22	16 to 22
7/8"	14 to 20		
1"	14 to 20	14 to 20	16 to 20
1 1/8"	14 to 20	14 to 20	16 to 20
1 1/4"	14 to 20	13 to 20	16 to 20
1 3/8"	14 to 20	13 to 20	16 to 20
1 1/2"	14 to 20	13 to 20	16 to 20
1 5/8"	14 to 20	11 to 20	16 to 20
1 3/4"	14 to 20	11 to 20	14 to 18
1 7/8"	13 to 20	11 to 18	16 to 18
2"	13 to 20	10 to 18	13 to 18
2 1/8"	13 to 20	13 to 18	13 to 16
2 1/4"	13 to 20	9 to 18	
2 3/8"	13 to 20	9 to 16	13 to 16
2 1/2"	13 to 18	9 to 16	12 to 16
2 3/4"	13 to 18	9 to 16	12 to 14
3"		9 to 16	
3 1/4"		9 to 16	
3 1/2"		9 to 16	
4"		9 to 16	
4 1/2"		9 to 16	
5"		9 to 16	

*These sizes can be made by welding direct to size (i. e. without cold drawing). Intermediate sizes, smaller diameters and wall thicknesses heavier than those shown above may be obtained if required. Square, rectangular, and special shapes available in limited range.

—and right now is the time to learn all about Republic ELECTRUNITE Aircraft Tubing and what it can do for you.

The table above, giving ELECTRUNITE analyses, sizes, and gauges—demonstrates the wide line of top-quality tubing available from a single source of supply—Republic Steel and Tubes Division. (Handy pocket-size cards bearing this table are yours for the asking.)

The use of countless thousands of feet of this tubing for wartime aircraft construction has demonstrated its consistent uniformity in wall thickness, diameter, concentricity, ductility, strength, weight and smooth surface—and its easy workability and weldability. It has been proved sound in every respect both by performance in service and by FARROWTEST — the most accurate commercial method for testing tubing.

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AIRCRAFT TUBING

P-59 Jet-Propelled Fighter. The first details about the Bell P-59 have been revealed by the Air Technical Service Command.

In appearance the jet-propelled aircraft closely resembles any midwing fighter. The fuselage is slender and slightly more extended in the nose. The wing is laminar flow, flat, and tapered, and the empennage is conventional. Flight power comes from two enclosed thermal-jet engines mounted next to the fuselage, one on each side, under the wing roots.

Basically, the thermal-jet engine is simple. At the front of the engine is an air-intake duct. The admitted air is picked up by rotary compressors that force large quantities of air under pressure into the combustion chamber. Here it is mixed with the fuel—kerosene—and the mixture is burned, the combustion causing constant high pressure. The force of the burning gases is directed through a turbine where its power is utilized to drive the compressors. Then the jet itself is nozzled down for greater force and emerges as a stream of gas driving the airplane. An outside source of electrical power is generally used to start the jet engine.

In operation, the P-59 runs so smoothly that a vibrator is installed on the instrument panel to keep the needles functioning properly by eliminating stickiness. The plane is rated so far at over 400 m.p.h. and is reported to perform well at high altitudes. It weighs more than 5 tons, has a span of 49 ft., and carries four 0.50-caliber machine guns. *Air Technical Service Command.*

Government Material for Sale. The Property Disposal Section desires to obtain outlets for the disposition of surplus materials and equipment. The following announcement is published at the request of the Chief of the section:

Raw and fabricated materials, standard parts, motors, hardware, fabrics, precision tools, equipment, and other surplus stocks are being offered for sale by the Army Air Forces.

Companies interested in such materials and who are desirous of having their names placed on the active bidders' list are invited to write to the Army Air Forces, Air Technical Service Command, Midwestern Procurement District, Municipal Airport, P.O. Box 117, Wichita, Kan., Attention: Property Disposal Section.

Aircrew Selection and Classification. An illustrated booklet tells of the scientific principles upon which selection of A.A.F. flying personnel is based. It shows how the employment of these principles not only has resulted in supplying America with the pilots, bombardiers, and navigators needed during the critical years of this war but also has resulted in a saving of time, equipment, and human life. *Army Air Forces Training Command, Office of the Surgeon.*

"Sky Hook" for Aerial Delivery. A container that provides accurate aerial delivery of emergency supplies has been devised and is now being tested by the miscellaneous equipment branch of the Air Technical Service Command. Called the "sky hook," it is a rotary-wing device adapted in shape for a method of descent similar to a falling maple seed.

Lt. Col. Verne Stewart examines the newly developed "Sky Hook" after a recent experimental drop test conducted by the A.T.S.C. personal equipment laboratory, Wright Field, Ohio.

Approximately 65 lbs. of food, medicines, and other emergency supplies may be packed in the bulbous plastic container, roughly 8 in. deep and 20 in. in diameter, which is the counterpart of the maple pod. The wing or blade of the sky hook, approximately 1 ft. wide and 3 ft. long, is a flat wooden frame covered by airplane cloth.

Released from a plane in a flat position, the sky hook spirals to the earth in a flat spin around its own center of gravity at an approximate speed of 35 ft. per sec. Drift is reported to be negligible and accuracy correspondingly greater.

The sky hook's major wartime use may be as an emergency supply kit for units isolated in combat. Postwar uses may include its employment as a device for aerial delivery of mail. *Air Technical Service Command.*

Aeronautical Board

ANC Bulletin Wood Aircraft Inspection and Fabrication. This bulletin contains technical data on wood, modified wood, glues, and processing which are of direct concern to fabricators and inspectors of wood aircraft. It supersedes the publications titled *Manual for the Inspection of Aircraft Wood and Glue for the United States Navy* issued in 1941 by the Navy Department Bureau of Aeronautics and the *Wood Aircraft Fabrication Manual* issued in 1942 by the Aeronautical Board.

One section of the bulletin presents basic information about wood, its characteristics and identification, and the requirements for wood in specific aircraft parts. Another tells about modified wood—plywood, laminated, compreg, impreg, and heat-stabilized wood. A third section, describing the different types of aircraft glues, their properties, and applications, also explains how the quality of glue is controlled. In a fourth section, the account of how wood is processed and fabricated for aircraft begins with the seasoning and storage of lumber, the control of humidity in factories, and gluing and assembly operations and continues with a study of bag-molded plywood and structures, temperature measurement, and machining, bending, and other woodworking operations. It also gives information about the finishing of wood in aircraft and the manufacture of propellers. *Army-Navy-Civil Committee on Aircraft Design Criteria, ANC-19,* December, 1943; for sale by the Superintendent of Documents, Washington, D.C., $1.00.

Plastics for Aircraft. In this bulletin general information is given about the mechanical and physical properties, the molding and fabrication techniques, and the typical applications of important plastics used in aircraft structures and parts. Acceptable to the Army Air Forces, Navy Bureau of Aeronautics, and the Civil Aeronautics Administration, the criteria have been prepared to aid in the design of both military and commercial aircraft. A pertinent list of specifications and a bibliography supplement the text. *Army-Navy-Civil Committee on Aircraft Design Criteria, Bulletin ANC-17,* July, 1943; for sale by the Superintendent of Documents, Washington, D.C., $0.40.

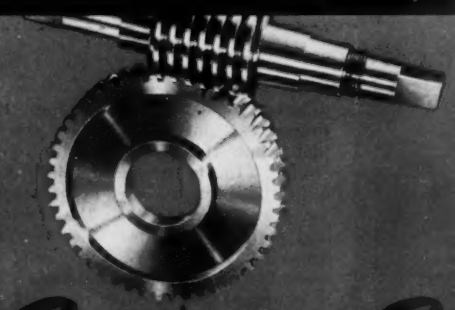
Army Service Forces

Why and How of the Vendors Shipping Document. Instructions on how to use the Army Service Forces' Vendors Shipping Document are supplemented by information about the purpose of this form. As explained, this one document replaces all Army forms formerly needed for ordering from vendors' plants, inspection, acceptance, shipping, shipment notification, and tallying-in. Expediting supplies to the troops, it is credited with simplifying handling, improving accuracy, and streamlining operations. Directions are given for domestic, overseas, and emergency shipments. *Office of the Quartermaster General,* June, 1944.

Civil Aeronautics Administration

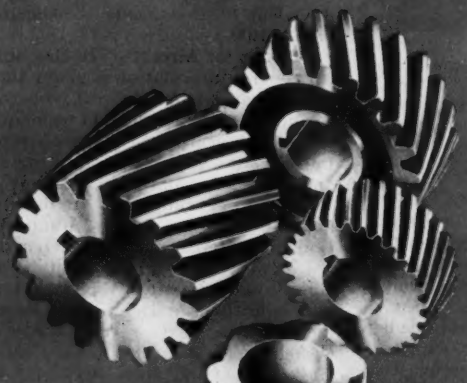
Airport Design. A presentation of elementary considerations in the study of airport site selections and in the design, planning, and construction of airports. In addition to providing basic information with regard to the general principles of airport design and construction, this publication is designed to assist in working out the details of a sound program of airport development.

It is divided into 12 chapters. The first deals with airport planning; the second, with the factors influencing airport size and includes pertinent tables and charts; the third, with the factors influencing the selection of the airport site; and the fourth, with investigation of soil conditions. Chapter five is on



Custom Engineered Gears

Now that the B-29 has been publicly announced it can be revealed that Pacific Gear Works and Western Gear Works have played a part in the tremendously important program of designing and constructing the American Super-fortress. Since 1941 Pacific-Western engineers have worked continuously with the Boeing Aircraft Co., the Air Forces Materiel Command, and other contractors for the huge bomber. Gears and geared actuators of many types have been built and tested.



★ Probably no other gear manufacturer in America has had as wide and varied experience in manufacturing gears for the Aircraft Industry as has this organization.

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★ In many planes, old and new, every gear in them, exclusive of power plants and props, was built in one of our four big factories.

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★ Our testing and manufacturing facilities are likewise flexible enough to quickly produce new gears and geared equipment for aircraft requirements.

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Builders of

Aircraft Gears: Spurs, Bevels, Helicals, Herringbones, Worms, Hypoids, Zerols and Spiral Bevels; Miniature Gear Sets in Case, Torque Shaft Actuators, Jack Screw Actuators, Drum Type Actuators, Superchargers, Transmissions, Wind Tunnel Drives.

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drainage systems; chapter six, on grading; chapter seven, on airport turf; and chapter eight, on airport pavement. Three other chapters discuss airport lighting, airport buildings, and airport maintenance. The remaining chapter is devoted to the subject of the master plan. It includes drawings of various types of runways, air terminals, and stages of airport development. *Airports Service, Civil Aeronautics Administration*, Washington, D.C., April, 1944.

Airplane Cruising Range Characteristics. Flight Engineering ' Report No. 11 presents in considerable detail a method, based upon direct flight testing, of measuring over the complete range the relatively important factors influencing airplane cruising-range characteristics. By means of this process the optimum power-plant operating conditions for maximum range may be determined at any altitude and airplane weight. It illustrates by means of an example the application of the method to a typical airplane over a typical range of the influencing factors. It examines several alternative forms in which these characteristics may be made available to operating personnel. It considers the effect of wind upon the optimum air speed for maximum range, and it discusses briefly the effect upon range of three alternative methods of cruising control. *Safety Regulation Release No. 165*, August 30, 1944.

Development of the High-Frequency Radio Range. P. B. King and T. A. Kouchnerkavich. Part II of a report on the development of the ultra-high-frequency radio ranges on towers discusses the factors affecting the usefulness of radio ranges from a theoretical standpoint; discusses the effect of reflections from the ground and from a counterpoise; shows the effect of height on distance range and continuity of signal; describes the apparatus used; and presents the data obtained at Indianapolis, Ind., and Van Nuys, Calif., during the latter part of 1941.

The investigation was begun using only vertical polarization at 63 megacycles on a 16-ft. wooden tower, first without a counterpoise and then with a 30-ft. counterpoise. Tests were made using both vertical and horizontal dipole radiators on the high tower. The second stage of the investigation was carried on at 125 megacycles using pure horizontal polarization. Tests were made on the 125-ft. steel tower with a counterpoise, on a 30-ft. pole without a counterpoise, on a 30-ft. wooden tower with a 30-ft. counterpoise, and then on a 22-ft. steel tower with a 35-ft. counterpoise.

The results obtained at Indianapolis are representative of what may be expected in flat country, while the results obtained at Van Nuys indicate what may be expected when an installation is made immediately adjacent to extremely mountainous terrain. The Van Nuys work was done using an improved ultra-high-frequency radio-range antenna system with pure horizontal polarization on a 22-ft. steel tower with a 35-ft. counterpoise. This antenna system was still further improved and reinstalled on the steel tower at Indianapolis, which had been shortened from 125 ft. to 22 ft. with the same counterpoise. The ultra-high-frequency range characteristics are contrasted to those of the lower frequency ranges in extremely rugged country.

The conclusions reached as a result of this investigation are that the high tower is impractical because of multiple low-angle lobes produced by reflections from the ground; the low tower is most satisfactory; and a counterpoise is essential and should be designed to limit the low-angle lobes to not more than two. With a slight increase in counterpoise diameter the lobes may be further limited. *Technical Development Report No. 43*, July, 1944.

National Research Council

The Report of the National Research Council for the year July 1, 1942, to June 30, 1943, contains a review of the general activities of the organization and detailed reports of the different divisions. The annual report of the treasurer and a summary of the financial operations for the year are included, as well as information about the library and the publications of the Council and a list of the officers and members. The work of several of the divisions will be of particular interest to those engaged in the various branches of the aeronautical sciences. *National Research Council*, Washington, D.C.

Navy Department

Gas-Turbine Patent Data. Five new Technical Literature Research publications are available from the Research and Standards Section of the Bureau of Ships, Navy Department, with regard to patents on gas-turbine plants. The five books are as follows:

The Swiss Patents on Gas Turbine Plants (1925–1942). This is a bibliography listing Swiss patents on gas-turbine plants from 1925 to 1942. It includes 589 patents, ranging from the Swiss Patent Classification numbers 107,278 to 219,485. The list is supplemented by indexes showing inventor, assignee, and patent number. A microfilm of complete text and plates of all patents cited is in the possession of the Bureau of Ships and may be consulted by authorized persons.

The German Patents on Gas Turbine Plants (1925–1942). Arranged by inventors and assignees, this bibliography is pertinent to German patents on gas turbines for the period January, 1925, through December, 1942. The total of 1,106 patents listed covers patents from No. 408,316 to 726,320. However, while descriptions of the patents through No. 707,127 (issued June 14, 1941) were received at the U.S. Patent Office, information about succeeding German patents was derived from the *Patentblatt* and the *Auszuege*, two German periodicals giving abstracts of patents and titles of applications.

Additional to the bibliography is a German subject-classification cross index, a patent-number index, and notes on early German gas-turbine patents. The U.S. Patent Office has a microfilm of complete text and plates of all the patents cited.

The German Patents on Gas Turbine Plants (1943). This list of German patents on gas-turbine plants granted in 1943 comprises 62 titles. They were obtained from copies of the *Auszuege* issued by the German Patent Office from January 1 to October 7, 1943. Items are arranged by German Patent Office classification groups and are supplemented by two indexes, one of inventors and the other of assignees. Microfilms of numbers 1 to 32 are in the possession of the Office of Strategic Services.

The United States Patents of Gas Turbine Plants (1925–1942). United States patents on gas turbines for the years 1925 through December, 1942, are listed in this report. The bibliography is arranged by means of a decimally symbolized classification, with notations and cross references. It is supplemented by classification, inventor, assignee, and patent-number indexes.

The Technical Literature of Gas Turbine Plants (1930 to Date). A survey of periodical literature, exclusive of patents, issued on gas-turbine plants from 1930 to May, 1942. By means of a decimally symbolized classification system, the report lists 350 articles. Annotations, cross references, and an index of authors are included. *Technical Literature Research of Research Section, Bureau of Ships.*

Port of New York Authority

Proposed Air Routes. As a part of the plan for postwar commercial air transportation, the Port of New York Authority has suggested international air services between New York and various points in the South American countries, the West Indies, Central America, and Mexico. These routes are outlined on a map, and statistical tables have been prepared showing the mileage and time differentials on the suggested routes.

War Department

Aerial Phototopography. Methods by which military organizations prepare

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maps from aerial photographs are reviewed in this manual. The information deals with the requirements for aerial photography, ground-established control, and maps reproduction preparation. Beginning with a section of general data, separate portions of the book are devoted to discussions of aerial photography, ground control, map projections, characteristics of aerial photographs, and radial-line mapping. There are also chapters on mapping from Tri-Metrogon aerial photography, photomaps, stereoscopic mapping, multiplex mapping, and special mapping methods. A glossary, list of references, and multiplex plotting and photograph data compose the three appendixes that complete the book. This manual supersedes *TM 5-240*, of November, 1941. *War Department Technical Manual, TM 5-240*, May, 1944; for sale by the Superintendent of Documents, Washington, D.C., $0.30.

Meteorological Balloons. Pertinent information about meteorologic balloons is offered in this brief study. The uses and types of balloons are surveyed, their installation and operation are described, and advice is given about methods of balloon maintenance. A supplementary table shows the meteorologic balloons and associated equipment listed by the Signal Corps together with the functions, color, weight, and dimensions of each. *War Department Technical Manual, TM 11-2405*, April, 1944; for sale by the Superintendent of Documents, Washington, D.C., $0.10.

Pilot Balloon Tables (30-Gram). A means of ascertaining the horizontal distances traveled by a 30-Gm. balloon from an observation point is provided by the tables comprising this book. The distances given are for the end of each minute of flight from the first minute through the sixtieth minute. With the manual superseding *TM 11-420*, these tables apply only to 30-Gm. balloons (Balloon ML-50, ML-51, ML-64, ML-155, and ML-156) which are inflated with hydrogen sufficiently to support the weight of Cock ML-56 in addition to the weight of the balloon. *War Department Technical Manual, TM 11-2410*, March, 1944; for sale by the Superintendent of Documents, Washington, D.C., $0.30.

Aircraft Power Plant Operation. One of the technical manuals published by the War Department, this is a guide to the operation and maintenance of aircraft power plants. It supersedes War Department manual *TM 1-408, Aircraft Engine Operation and Test*, of December, 1941.

The current book is divided into four major sections. The first, on power plant operation, offers advice about cockpit controls; engine instruments; operating factors and their control; operation limits; engine starting, warm-up, operation check, and engine stopping; flight operation of the engine; and refueling. Section two is concerned with the inspection and maintenance of power plants. It outlines the purpose, routines, and require-

ments of preflight, daily, 25-hour, 50-hour, engine-change, and special inspections. The third section discusses trouble recognition, analysis, and elimination. The fourth section investigates the possible causes of common power-plant troubles. *War Department Technical Manual TM 1-408*, March, 1944; for sale by the Superintendent of Documents, Washington, D.C., $0.30.

Pilot Balloon Tables (100-Gram). Superseding *TM 11-2411* of September, 1943, this manual consists of a group of tables for determining the horizontal distances traveled by a 100-Gm. balloon from an observation point. The distances given are for the end of each minute of flight from the first minute through the sixtieth minute. Tables are applicable only to 100-Gm. balloons (Balloon ML-159, ML-160, and ML-161) which are inflated with hydrogen sufficiently to support the weight of Cock ML-201-A in addition to the weight of the balloon. *War Department Technical Manual, TM 11-2411*, April, 1944; for sale by the Superintendent of Documents, Washington, D.C., $0.30.

Catalog of the United States Armed Forces Institute. The second edition of this catalogue contains a description of the functions of this official Army and Navy school operated under the War Department directive. It is intended to provide the personnel of the armed forces with information about the educational opportunities available to them while in the service of the nation. It tells about a plan whereby spare time can be utilized by service personnel to increase their value to the military services and to prepare for desirable employment upon their return to civilian life. It gives instruction about enrollment both in the United States and overseas, outlines the qualifications required, and describes the many types of instruction made available through the facilities of the Army and Navy. Enrollment is available to enlisted men and officers.

The book contains a list and brief descriptions of the educational courses provided and the names and addresses of cooperating colleges and universities. *Prepared by the Morale Services Division, Army Service Forces*, War Department and the *Educational Services Section, Bureau of Naval Personnel*, Navy Department. Copies may be obtained from any librarian or chaplain; from special service, education, and orientation officers of the Army; from educational service officers and education officers of the Navy; or by writing to the Commandant, United States Armed Forces Institute, Madison 3, Wis., or to any of the branches of the U.S.A.F. Institute.

Australian Council for Aeronautics

The Inauguration of the Australian Council for Aeronautics. This brochure gives an interesting overall picture of the development of aeronautics in the Commonwealth of Australia. The early work of Hargrave is recounted with great pride. He was the first worker in this field and the author of 19 papers on aeronautics, the first of which appeared in 1884.

Beginning in 1913 systematic instruction was commenced in the University of Melbourne. By 1924 an aircraft experimental station was established, but it was not until 1937 that research was undertaken on a large scale. The organization of the Council, which follows the pattern of the N.A.C.A. in many respects, brought aeronautical research under the direction of able scientists. This report is an account of the beginnings of the work of the Council. *Council for Scientific and Industrial Research, Division of Aeronautics*, Melbourne, Australia.

Interference in a Wind Tunnel of Regular Octagonal Section. Betty L. Gent. The interference on a small wing in a tunnel of regular octagonal section is determined by first mapping the octagon on a half-plane and then applying the method of images to find the flow in this half-plane. In the case of finite span, the octagon is mapped on a circle and the value of the interference deduced, both for uniform and elliptic lift distribution. All the results obtained are extremely close to the corresponding results for a tunnel of circular section. *Report ACA-2*, January, 1944.

Interference on Wings, Bodies, and Airscrews in a Closed Tunnel of Octagonal Section. G. K. Batchelor. Aerodynamic models tested in a wind tunnel are subject to some interference from the presence of the tunnel boundaries. Most of the corrections for this interference are known in the case of open or closed tunnels of rectangular, circular, or elliptic cross section. The object of this paper is to review all the interference corrections appropriate to a tunnel of octagonal section or, where they do not exist, to deduce them. Although the methods are general, numerical application is made to the particular case of the Division of Aeronautics closed tunnel, of cross section as given in the paper.

The effect of the tunnel boundaries on angle of incidence, drag, down-wash, tailsetting to trim, and maximum lift of a wing of finite span is deduced, and then wings that extend right across the tunnel are considered. Expressions are given for the changes in drag which occur when two- and three-dimensional nonlifting systems are tested in rectangular and octagonal tunnels. Finally, the interference on propellers and the interference on wings when model propellers are running are reviewed, these expressions being the same for all shapes of tunnel cross section. *Report ACA-5*, March, 1944.

British Air Commission

New Spitfire Types. The following information has been released regarding recent versions of the Spitfire:

Sea Otter I. The Vickers Armstrongs (Supermarine) Sea Otter I is a single-engined amphibian biplane designed for naval spotting, reconnaissance, and general purpose duties. It is also engaged on Air-Sea Rescue duties. It has a catapult equipment. It is powered with a Bristol Mercury 30 engine of 870 hp., driving a Rotol three-blade, variable-pitch, constant-speed propeller. The main planes are arranged to fold and the land undercarriage is retractable. The armament consists of three Vickers 0.303 "K" guns. Bombs or depth charges are carried. It has a crew of three or four.

The dimensions are: span, 46 ft.; length, 39 ft. 4 3/4 in.; height (tail down), 16 ft. 2 in.; wing area (main planes), 610 sq. ft.; weight, about 10,000 lbs.

Seafire III. The Seafire III is a single-engined, low-wing monoplane single-seater fighter with single fin and rudder. It is powered by a Rolls-Royce Merlin 55 engine of 1,470 hp., driving a Rotol four-blade propeller. The Seafire III operates from aircraft carriers and is fitted with arrestor and catapult gear. It has folding wings. The armament consists of two 20-mm. cannon and four 0.303 Browning guns.

The dimensions are: span, 36 ft. 8 in.; length, 30 ft.; height, 8 ft.; wing area, 242 sq.ft.; weight, about 8,000 lbs. *British Air Commission*, Washington, D.C.; *British Information Services*, New York.

Warwick Air-Sea Rescue Airplane. The following details were issued in London late in September concerning the Warwick air-sea rescue airplane, designed by Vickers Armstrongs. This is a midwing monoplane with a single fin and rudder and of geodetic construction. It has a wing span of 96 ft. 9 in., a length of 72 ft. 3 in., a height of 18 ft. 6 in., a wing area of 1,020 sq.ft. and weighs about 43,000 lbs. The airplane is powered by two Pratt & Whitney Double Wasp 1,850-hp. engines.

The plane has a crew of seven, and is used for general reconnaissance purposes. Its armament consists of eight 0.303-caliber machine guns—two in the forward turret, two in the dorsal turret, and four in the tail turret. The plane is equipped with an air-borne lifeboat. *British Air Commission*, Washington, D.C., *British Information Services*, New York.

New Incendiary Bomb. Another new and devastating incendiary bomb has been added to the armament of British bomber aircraft by the Ministry of Aircraft Production. The new bomb weighs 30 lbs. Its length is approximately 21 in. and its diameter 5.5 in. The main filling of this bomb consists of a solution of methane in gasoline under pressure. Its descent is controlled by a parachute which reduces its terminal velocity. When the bomb is functioning it emits from its tail a jet of flame about 15 ft. long and 2 ft. wide. The following is a brief description of the action of the bomb on impact.

OVER THE HUMP

High over the "hump," the Air Transport Command delivers another one. Rangoon, Moscow, Burma or Bermuda—names on a map are just stopping-off points for the shuttle shift. Flying the "roof route" or skimming the white-tops, the Air Transport Command is doing noble work, unsung in headline or on loudspeaker. Thousands of planes every month are being delivered safely from factory to fighting line, ready for action.

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The striker of the bomb fires the detonator; the flash from the detonator ignites the priming in a central tube; the priming ignites the thermite and this heats the interior of the bomb, raising the internal pressure. When the pressure has been raised sufficiently, the gasoline is forced through the flexible tube into the valve chamber, through the outlet hole in the jet, and through the hole in the bottom of the parachute container. As it passes out of the jet, the gasoline is ignited by the flame issuing from the vent holes in the striker housing. As a result of the burning thermite the jet of flame thrown will continue for a period of 2 min. The bomb is the outcome of long and intensive research by the Ministries of Aircraft Production and Home Security in conjunction with Leeds University. The production and filling stages were done by Imperial Chemical Industries Limited. *British Air Commission*, Washington, D.C.

The Mark 11D Gun Sight has brought about a great improvement in aerial fighting. Fighter pilots may now open effective fire on their opponents with the speed of each aircraft upward of 400 m.p.h. at ranges of over 400 yards and at angles of deflection that were considered to be impracticable only a few months ago. This gun sight was developed at the Ministry of Aircraft Production Experimental Establishment. It is simple to use despite the complexity of its internal construction.

The sight consists of numerous electrical units supplying information to a sighting head that is immediately in front of the pilot. On the sighting head there is a glass screen $4^3/_4$ in. by $2^1/_2$ in., known as the reflector, on which the pilot sees the graticule and through which he sees the enemy aircraft. The pilot has only two adjustments to make to the sight as he goes into attack—first, by turning a lever he adjusts the sight for the type of aircraft he is attacking, then by turning a twist grip that is incorporated in the throttle at his left hand, he sets the range at which he is attacking. These procedures automatically feed the correct electric currents into the sight, whereas in previous sights the aiming graticule or ring was fixed.

The graticule on the new sight, which consists of six diamonds arranged in a circle around a center spot, moves on the reflector as a result of the pilot's or the enemy's maneuvers; it also expands or contracts according to the adjustment of the twist grip. On going into attack, the pilot adjusts the diameter of the moving graticule so as to contain exactly the wing span of the enemy aircraft. With his hand on the throttle, as he shortens his range, he drops his wrist to open the graticule, at the same time keeping the central aiming dot on a vital part of his opponent. In doing this, the pilot knows that the sight is making all the necessary deflection allowances required to register hits correctly, despite the fact that deflection shooting is now taking place at wide angles of attack and at greater range.

Combat results show that the efficiency of British fighter aircraft as measured by the ratio of kills to combats has been nearly doubled by the introduction of this sight. British Information Services, New York.

British Air Ministry

Gas Starter Systems for Aero-Engines. A handbook has been issued which describes aircraft gas starting systems in which a combustible fuel-air mixture under pressure is used as the initial means of rotating the crankshaft. Information is given about two systems: the Bristol or Mark I, and the Type A, originally known as the R.A.E. (Royal Aircraft Establishment) Mark II system. It is explained that the latter system is a development of the former and enables the smaller types of airplanes to have a self-contained starting system. The type A system is superseding the Mark I system. The components of both types of starter are described, including the air bottles; foot-operated air pumps; atomizers; primers; engine-gas distributors; and compressor units, which incorporate an air pump driven by a single-cylinder, two-stroke engine. The servicing of the equipment is described. His Majesty's Stationery Office, London, 2s.; British Information Services, New York, $0.60.

British Information Services

5 Years of War. Text and pictures give a review of the war effort of the British Empire during the first 5 years of World War II. A section tells of the accomplishments of Britain's air power, and charts show the comparative records of the Royal Air Force and the Luftwaffe in the tonnage of bombs dropped.

Report on the Flying Bomb. A verbatim report of a press conference held at the Ministry of Information, London, September 7, 1944. In it are described measures taken by the British government to combat the flying bomb, beginning with Allied attacks against the factories and launching sites in Germany and France even before the robot bombing of England commenced.

A chronological summary at the end of the paper briefs the history of Britain's fight against the robot from April, 1943, when information first reached London that the Germans were developing such a weapon, through August 28, 1944. It includes information about the number of Allied casualties which occurred as a result of the robot bombs, the number of buildings damaged, the number of bombs that were brought down by the counter measures, etc. *British Information Services*, New York, Information Division, ID 549, September, 1944.

A Method for the Rapid Evaluation of Glauert's Expressions for the Angle of Zero Lift and the Moment at Zero Lift. R. C. Pankhurst. A method is described by which the zero-lift angle of a given airfoil section can be rapidly calculated. This angle, measured in degrees to the same datum line as that to which the upper and lower surface ordinates are referred, is obtained in a formula utilizing a given coefficient appropriate to each station. A formula is also derived for obtaining the moment at zero lift. *Ministry of Aircraft Production, Aeronautical Research Committee, R. & M. No. 1914*, British Information Services, New York, $0.60.

The British Fleet Air Arm is a small folder containing pictures and explanatory captions which illustrate the different activities of the Fleet Air Arm. The pictures show the training of men and women, aircraft aboard battleships, various phases of carrier operations, and the results of the aerial bombing of enemy battleships and shore installations. *British Information Services*, New York.

British Ministry of Labour and National Service and the Ministry of Production

Controlling the Plan During Manufacture. The first two articles in this series, contributed by a member of the production department of an aircraft factory employing about 2,000 people, have been devoted to a description of the system adopted for the planning of production and for the control, in accordance with plan, of some of the steps preparatory to manufacture.

In this article some attention is given to the control of the manufacturing operations themselves. Mechanisms of control designed to assist the management in the overall control of production are described. It is explained that throughout the control of manufacturing operations there are two important and closely related considerations. One is a problem of priorities—that is, the matter of making sure that the work on the aircraft parts going through the shops reaches the stockrooms by the date when the components will be required for assembly.

The other is the problem of relating the volume of work going through the shops to the available labor and machine tool capacity so as to avoid production bottlenecks, on the one hand, and excessive idle time, on the other hand.

Sections of the article discuss the problem of getting all orders to the stock bins on time, relating capacity to the program, the labor master card, available and potential shop load, and shop programs. Also discussed are the considerations that lead to the adoption of the time cycle and target-date method instead of a system of priorities based on anticipated assembly line shortages. *Production and Engineering Bulletin*, August, 1944.

THE NEW ALTAIR HYDRAULIC *Shutoff Valve*

THIS NEW two-way Shutoff Valve—already in production and being used on the latest military airplanes—has been designed for easier installation—lighter weight—and dependable operation. The valve provides a positive shutoff for any section of a hydraulic system to prevent fluid loss in an emergency.

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The valve weighs only 0.5 pounds. Write today for complete data. Pacific Division, Bendix Aviation Corporation, North Hollywood, California. Sales Engineering offices in New York and St. Louis.

* U. S. Patents Pending

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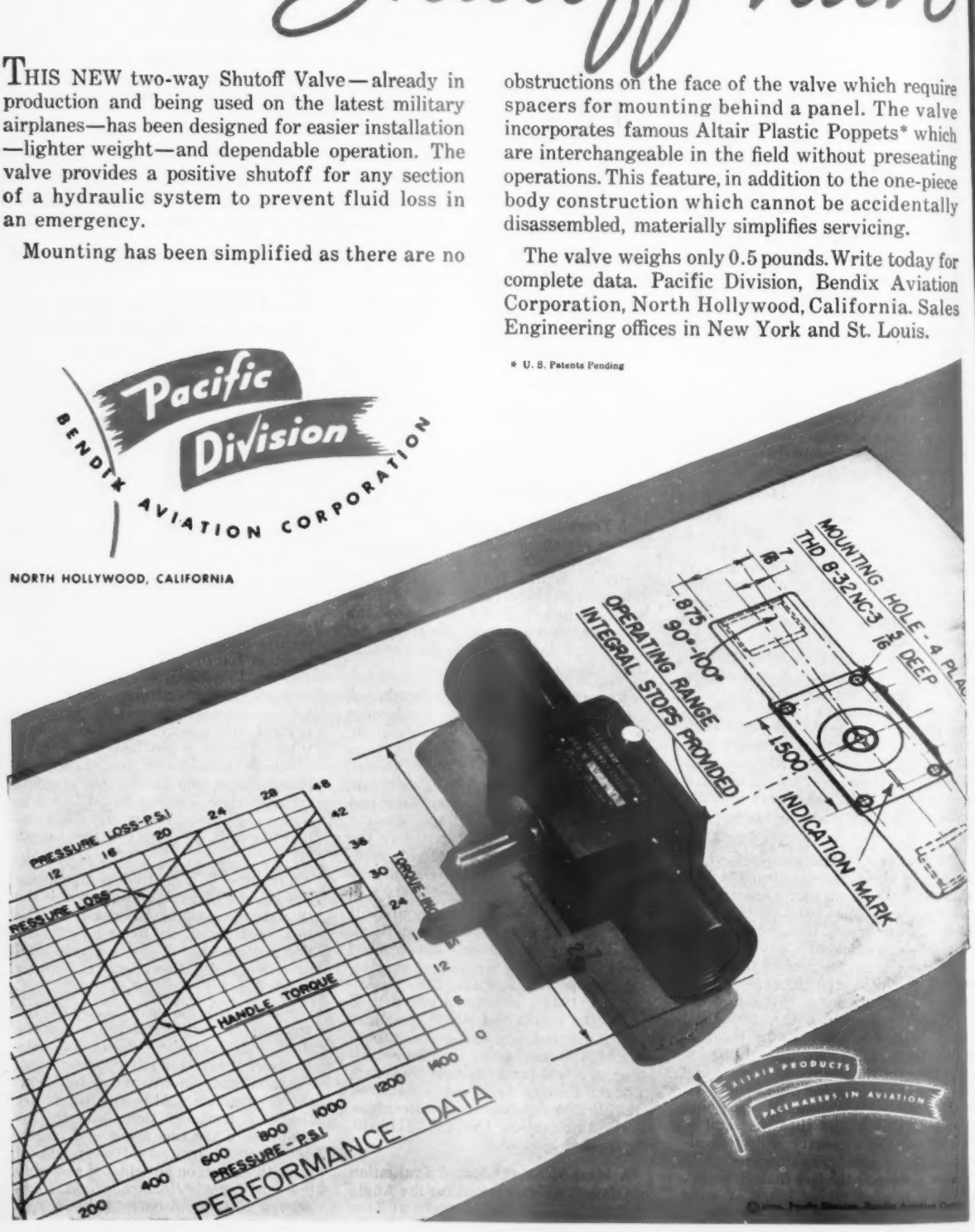

British Air Ministry Translations

The list below supplements those published in previous issues of the AERONAUTICAL ENGINEERING REVIEW.

Aeronautical companies and other organizations may borrow copies of these translations through the facilities of The Paul Kollsman Library upon application by the company librarian. Because of the importance of this material, the regular library loan period has been extended to two weeks, in order that these translations may be utilized to their full advantage. Requests should be made by number, author, and title on the regular Library book request cards. Because of the many requests for these translations, no more than five copies may be borrowed at one time by one organization.

The translations have been reproduced from typewritten copy, and the number of pages in each is indicated at the end of each reference. Bibliographic information has been taken directly from the translations. Photostatic copies are also available at the usual library rates.

1397 Schmidt, A. *The theory of the compression phase in gases and of the detonation wave.* Zeitschrift für das gesamte schiess- und sprengstoffwesen, v. 27, 1932, no. 5, p. 145–149, no. 6, p. 184–188, no. 7, p. 225–228, no. 8, p. 264–267, no. 9, p. 299–302. 38 p.

1395 Gassner, E., and Pries, H. *Wohler diagrams for cylindrical specimens made of Cr-Mo steel, duralumin, hydronalium and electron.* Luftwissen., v. 8, no. 3, March, 1941, p. 82–85. 13 p.

2181 Khlebnikov, T. S. *Antimony-caesium photo cells.* Communications engineering news, U.S.S.R., v. 9, no. 12, December, 1940, p. 65–70. 7 p.

2182 *Electric fuel meter of the sampling type.* Zeitschrift des Vereines deutscher ingenieure, v. 87, no. 35-36, September 4, 1943, p. 556. 3 p.

2183 AEG-beleuchtungskörper, g. m. b. h. *Wire connections by electric welding.* Zeitschrift des Vereines deutscher ingenieure, v. 87, no. 35-36, September 4, 1943, Advertising section, p. 35, 2 p.

2184 Bosshard, M. *Investigation on the causes of grain boundary corrosion in age-hardened Al-Cu-Mg alloys.* Schweizer archiv, v. 6, no. 10, October, 1940, p. 265–279. 17 p.

2185 Sauer, R., and Pösch, H. *Integrating machine for ordinary differential equations.* Zeitschrift des Vereines deutscher ingenieure, v. 87, no. 15-16, April 17, 1943, p. 221–224. 8 p.

2186 Marsch, O. *Construction and operation of rooms for testing the effect of climate on apparatus for the transmission of news.* Elektrotechnische zeitschrift (Deutsche auslandsausgabe), v. 64, September 23, 1943, p. 507–510. 11 p.

2187 Heinkel, Ernst, flugzeugwerke. *Collecting the condensate from wing surface condensers.* German patent, no. 736,722. Flugsport, v. 35, no. 14, October 20, 1943, Patent collection, no. 9, p. 61–62. 2 p.

2188 Junkers flugzeug- und motorenwerke a. g. *Cabin airheater (exhaust operated).* German patent, no. 734,304. Flugsport, v. 35, no. 14, October 20, 1943, Patent collection, no. 9, p. 62. 3 p.

2189 AEG-beleuchtungskörper, g. m. b. h. *Variable pitch mechanism operated by thermal expansion of control member (electrically heated).* German patent, no. 734,871. Flugsport, v. 35, no. 14, October 20, 1943, Patent collection, no. 9, p. 58. 2 p.

2190 Junkers flugzeug- und motorenwerke, a. g. *Boundary layer control by suction.* German patent, no. 736,114. Flugsport, v. 35, no. 14, October 20, 1943, Patent collection, no. 9, p. 62. 2 p.

2191 Deutsche versuchsanstalt für luftfahrt, e. v. *Method of ventilating and heating pressure cabins.* German patent, no. 737,644. Flugsport, v. 35, no. 14, October 20, 1943, Patent collection, no. 9, p. 59. 3 p.

2192 Voigt, C. A. *Elastic support for engines mounted in tandem.* German patent, no. 736,594. Flugsport, v. 35, no. 14, October 20, 1943, Patent collection, no. 9, p. 60–61. 2 p.

2193 Arado flugzeugwerke, g. m. b. h. *Construction of fixed and retractable radiators.* German patent, no. 735,302. Flugsport, v. 35, no. 14, October 20, 1943, Patent collection, no. 9, p. 61. 2 p.

2194 Schroeder & co., g. m. b. h. *Parachute opening shock damper.* German patent, no. 736,638. Flugsport, v. 35, no. 14, October 20, 1943, Patent collection, no. 9, p. 64. 2 p.

2195 *The centrifugal casting of gear wheels.* Zeitschrift des Vereines deutscher ingenieure, v. 88, no. 7-8, February 19, 1944, p. 100. 2 p.

2196 *Flash butt welding for tool tips.* Zeitschrift des Vereines deutscher ingenieure, v. 88, no. 7-8, February 19, 1944, Advertising section, p. 27. 2 p.

2197 Kühl, R., and Raab, K. *A photographic profile recorder for airscrews and wing models.* Luftwissen., v. 5, no. 5, May, 1938, p. 183–185. 8 p.

2198 Hantzsche, W., and Wendt, H. *The effect of compressibility on thin, slightly-cambered profiles at subsonic speeds.* Zeitschrift für angewandte mathematik und mechanik, v. 22, no. 2, April, 1942, p. 72–86. 25 p.

2199 Balabukh, L. I. *The stability of plywood plates.* Technika vozdushnogo flota, U.S.S.R., v. 11, no. 9, September, 1937, p. 19–38. 21 p.

2200 Pfriem, H. *The laws of reflection of two-dimensional pressure waves of large amplitude.* Forschung auf dem gebiete des ingenieurwesens, v. 12, no. 5, September–October, 1941, p. 244–256. 19 p.

2201 Czerlinsky, E., and Zeyns, J. *Reserve fuel meter for aircraft.* Luftfahrtforschung, v. 20, no. 8–9, October, 1943, p. 263–267. 7 p.

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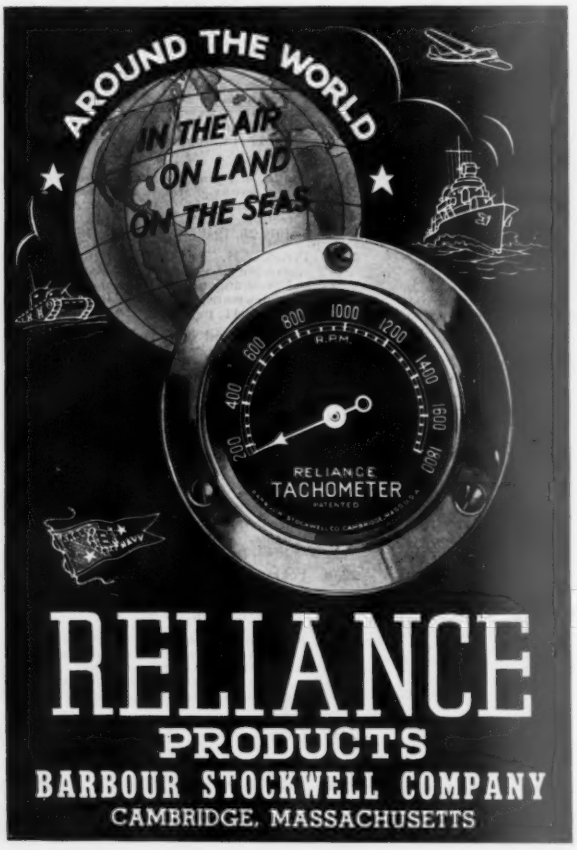

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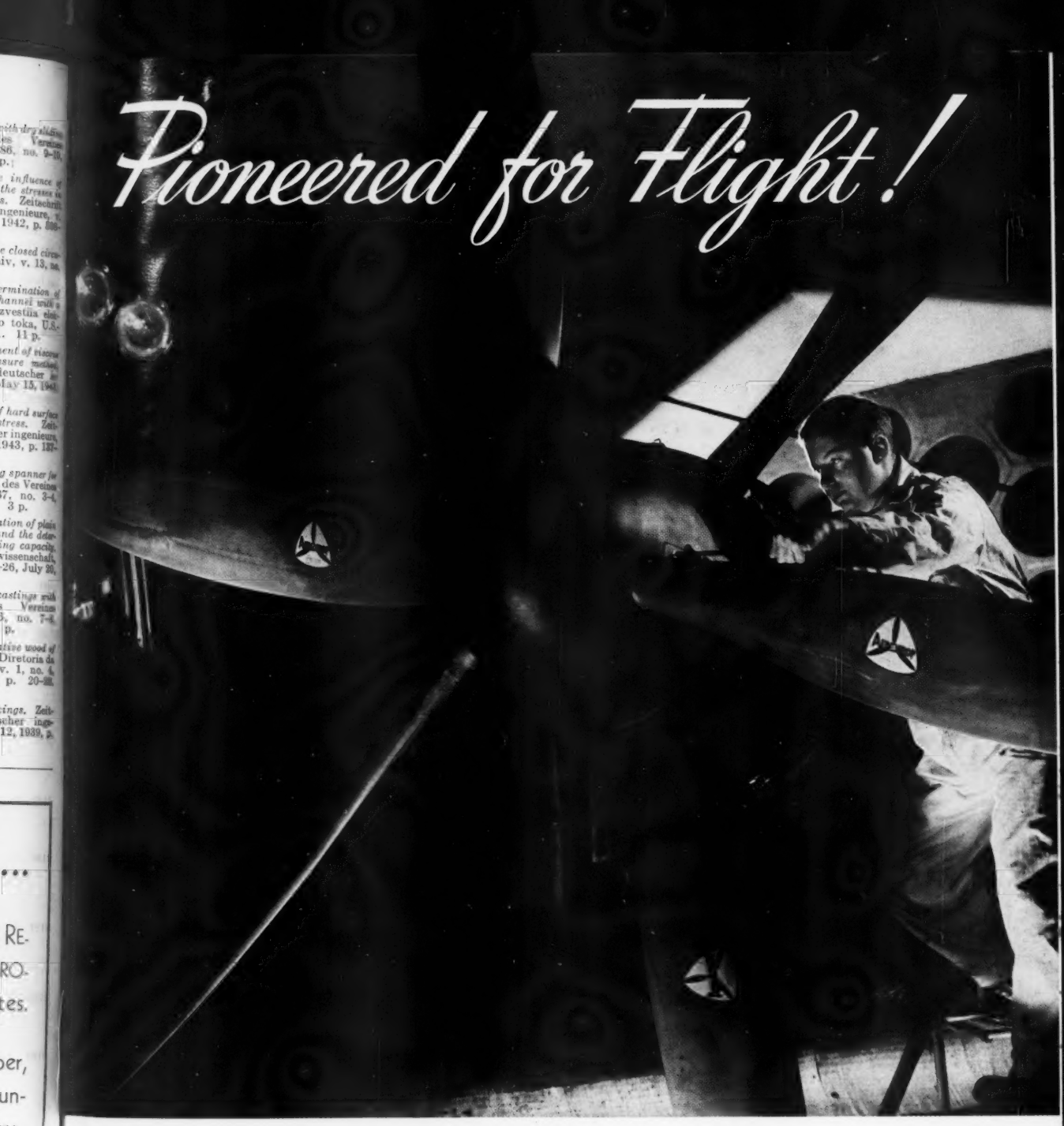

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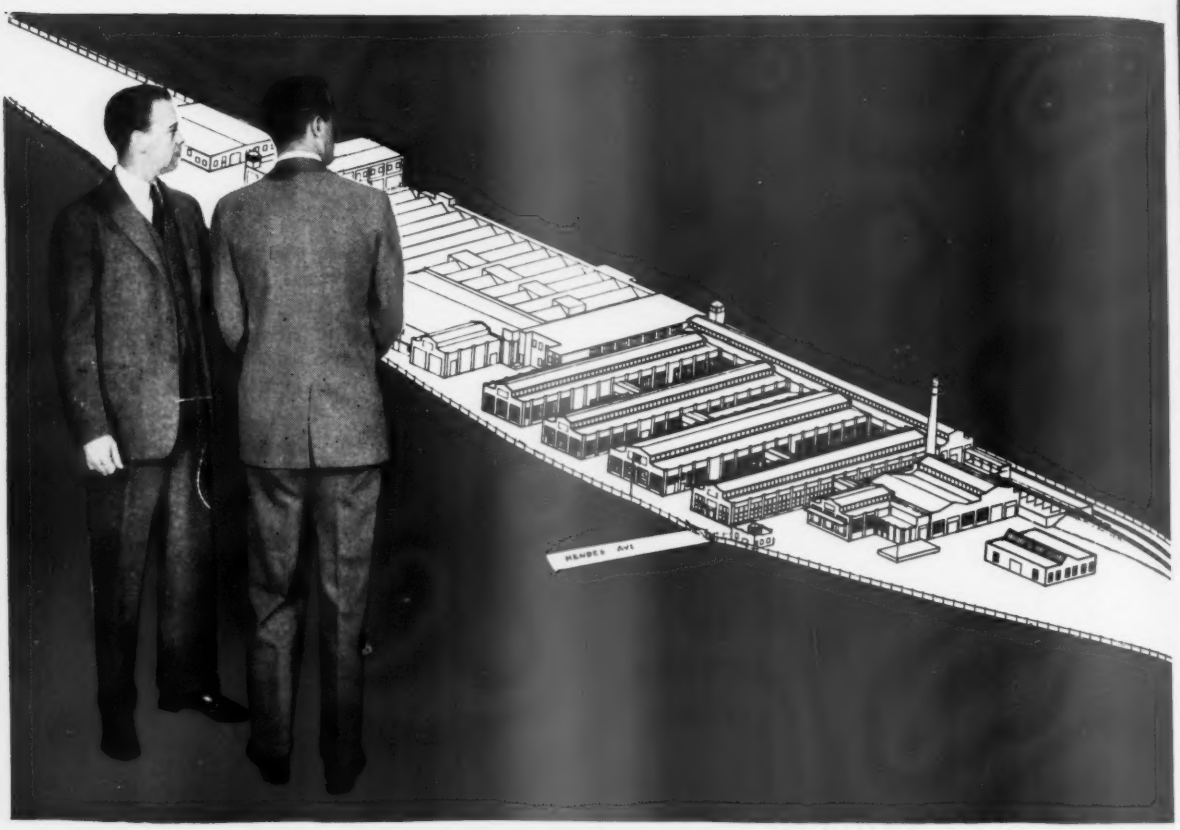

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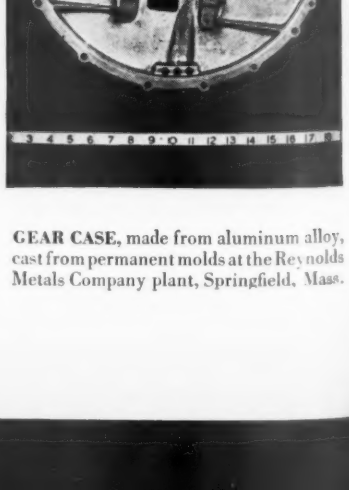

GEAR CASE, made from aluminum alloy, cast from permanent molds at the Reynolds Metals Company plant, Springfield, Mass.

With the exception of aeronautical annuals and books published outside the United States, books reviewed in this section may be borrowed without charge from The Paul Kollsman Library of the Institute of the Aeronautical Sciences, 1505 RCA Building West, 30 Rockefeller Plaza, New York 20, N. Y.

Anything a Horse Can Do

Col. H. F. Gregory

Contents: Da Vinci to De Bothezat; The Army's First Helicopter; Further Developments; Here It Is, Fly It; The Gyroplane; Eyes for the Big Guns; Back to the NACA; The Army's First Rotary-Wing-Aircraft School; The Army's Second Helicopter; Igor Sikorsky; We Buy the Sikorsky XR-4; The Demonstration; The XR-4 Goes West; The How and Why; Tests at Wright Field; Let's Take a Ride in the XR-4; The Bunker Hill; We Fly the Mail; The James Parker; The YR-4 Goes North; Lookout in the Sky; The Army-Navy Helicopter; Other Helicopters; The Future of the Helicopter.

The rotating-wing aircraft field has needed a book that does not overemphasize any one type. Colonel Gregory, who received the Thurman H. Bane Award from the Institute last year for his contributions to the development of the helicopter, has written an excellent survey of the history, development, and possibilities of this type of flying machine. His conservatism is commendable for one who is so enthusiastic about the possibilities of helicopters.

After reviewing the history of the attempts and failures of early experimenters, he tells of the progress made with the gyroplane, as best exemplified by the autogiro. He explains its possibilities and its limitations. The story of the efforts of the Army to secure a successful helicopter is told, including details of the trials and setbacks encountered. Its value for military work has been demonstrated, and it is now in use for many operational activities. Each of the many types now being made is described and its special features and advantages are outlined.

The book will be a standard reference book for those who wish to become informed regarding rotating-wing aircraft. Readers will not become overenthusiastic about any imaginary future possibilities. Colonel Gregory gives only the uses he can see, from the point of view of his experience, for all present and restricted models. Reynal & Hitchcock, New York, 1944; 243 pages, $3.00.

Plastics in the World of Tomorrow

Capt. Burr W. Leyson

Contents: A General Survey of the Uses of Plastics in Industry; The Fields and Opportunities for a Career in the Plastics Industry; Cellulose Nitrate or Pyroxylin—First of the Plastics; Shellac Plastics; Bitumen Plastics; Phenol-Formaldehyde Plastics; Casein Plastics; Cellulose Acetate Plastics; Urea-Formaldehyde Plastics; Vinyl Resin Plastics; Styrene Plastics; Acrylic Resin Plastics; Cellulose Mixed Ester Plastics; Ethylcellulose Plastics; Lignin Plastics; Alkyd Resin Plastics; Coumarone-Indene Resin Plastics; Aircraft Plastics; Electronic Bonding of Plastics; Compression Molding; Injection Molding; Extrusion Molding; Lists of Uses in Various Industries.

For those unfamiliar with the many different kinds of plastic materials and the uses to which each may be put, this book will serve as a handy guide. The author does not attempt to give a chemical analysis of any of the plastics but prefers to describe them in general terms that the layman can understand.

The first two chapters examine the opportunities offered for a career in the plastics industry. This field is broadly divided into two classes: The first incorporates the work of promotion and sales, including the finding of new applications and uses. The second is the technical section of the industry, in which chemical engineering and other scientific education is required. Other parts of the book give the characteristics and industrial uses of plastics, and information about the processes used in fabricating them. Two chapters are devoted to plastics in the aircraft industry.

The book emphasizes the many parts of aircraft construction that are made of plastic and describes in detail the Duramold process of bonding wood and fabrics. Any reader will have a broader idea of the plastics industry by reading this book. E. P. Dutton & Company, Inc., New York, 1944; 184 pages, $2.50.

The Royal Air Force in the World War—Volume II

Capt. Norman Macmillan

Contents: Stage for Blitzkrieg; The Battle of Holland; The Battle of Belgium; The Battle of France; The Air Battle of Britain.

The first volume of this history gave the preliminary background of the Royal Air Force from the time of the first World War and its record through the campaign in Norway. This volume carries the history through the battles of Holland, Belgium, France, and Britain.

Although there are many details that cannot be written at this time, Captain Macmillan has given the most complete account of the successes of the R.A.F. that has yet been published. He not only describes the strategy and tactics of the air forces engaged in these actions, which are epics in aerial warfare, but permits many pilots to give their eye-witness accounts. The press has given all the battles excellent coverage but, until it is compressed into a coherent account, the magnitude of the air attacks of the Axis powers and the heroic defense of the Allied airmen is not likely to be fully realized.

This history can be read by one who does not understand the technicalities of air fighting, since it is written in clear and readable style. It will serve as the standard reference book on the European air war until the time comes when it is possible to disclose the results of bombing operations in Germany as well as in England.

An elaborate appendix gives some of the details of the German raids, a list of the squadrons of the Fighter Command, and a chronology of the activities of the Bomber Command up to December 5, 1940. Comparative losses are given. A list of the British Air Aces of the Fighter Command gazetted up to January 31, 1941, is included. George G. Harrap & Company, Ltd., London, 1944; 352 pages, 2*s.* 6*d.*

The Book of Westland Aircraft

Compiled by A. H. Lukins; *edited by* D. A. Russell

Contents: Westland Aircraft; Westland Staff; Westland-Built Aircraft; Scale of Westland-Built Aircraft.

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their engines and electric plants. In 1915 Ernest Petter placed all their manufacturing services at the disposal of their government.

With R. A. Bruce as guiding director, the aeronautical expansion of the company began, and from then until now it has produced some of the best-known aircraft in the world. The novel Pterodactyl tailless monoplane, which was designed by Capt. G. T. R. Hill, was built by Westland.

The section of the book giving the history of the company is illustrated by photographs of the plant interior, of various types of aircraft, and of important events and personalities. Following that is a section containing descriptions, specifications, photographs, and drawings of aircraft built by the Westland company.

The company's record is a long and notable one, and the account of its achievements makes interesting reading. Compiled and published with the cooperation and approval of Westland Aircraft Limited by The Harborough Publishing Company, Ltd., Leicester, England, 1944; 104 pages, 2*s*. 6*d*.

Foreign Maps

Everett C. Olson and Agnes Whitmarsh

Contents: Maps of the United States; Methods in Reading Foreign Maps; Marginal Information; Map Indexes; Problems of Languages; Languages of the Principal Nations and Territories of the World; Signs and Symbols; Scales and Measurements; Grid Systems; Characteristics of Maps of Principal Foreign Mapping Agencies.

At a time when airmen are using maps produced in many different countries and printed in languages they do not understand, this book will be useful in giving them the essential translations required to read maps in practically all the languages they may encounter.

The book is the fifth in the publisher's Geoscience Series. It is based on new techniques developed in the teaching of map interpretation and on the experience of the authors in their work at the University of Chicago. It has been the aim of Dr. Olson, teacher of cartography in the Army Specialized Training Program and in the Institute for Military Studies, and of Miss Whitmarsh, Map Librarian at the University, to provide a concise text and reference book in simplified form, bringing together information that was formerly available only in scattered volumes. It includes procedures in obtaining and studying maps, materials vital to studies of maps, explanations of signs and symbols, selected references for additional information regarding certain phases of map work, and a complete index.

The glossaries give the English equivalents of the terms commonly used in map making in the different foreign languages, so that a knowledge of those languages is not required for map reading. The final chapter, on the characteristics of maps of various agencies, is to be used for reference rather than in studies of problems of interpretation.

The explanations of how maps are made and the differences of methods and of designations will be especially helpful to pilots and navigators in the Far East. The presentation, although technical, gives a broad understanding of maps, but does not include the usual strip maps used for air navigation. Harper & Brothers, New York, 1944; 237 pages, $4.00.

Tomorrow's Customers for Aviation

Contents: Public's Interest in Aviation; Commercial Airline Travel; Personal Planes and Private Flying; Kind of Plane Desired; Airports; Postwar Employment Plans of Military Flyers; Airplane Sales and Distribution.

This pamphlet contains a statistical study of the potential market for air passenger transportation and private airplanes. The questionnaire from which the resulting tables were obtained was submitted to civilians and Army and Navy fliers.

The statistics were compiled from the results of interviews with 2,000 civilians representing the upper half of the nation's urban population in terms of income and standard of living as established by certain arbitrary financial qualifications, localities, and other factors, all of which are explained. The interviews were conducted by trained investigators employed by a disinterested organization specializing in the gathering of such statistics. In addition to the 2,000 civilians, 500 Army and Navy airmen were questioned about owning private planes after the war. The results are tabulated and charted. Explanations of the methods followed and other comments are given in a summary.

There is clear evidence that the development of postwar traffic, both in this country and from the United States to foreign cities, will be rapid. The problem of the private ownership of airplanes is more difficult to solve. The younger generation indicates a great desire to own airplanes, but women are in the minority of the prospective owners.

The preferences for types, price range, and makes are shown. Nearness to an airport is an important factor for the private owner in reaching a decision. The broad scope of the research gives a general idea of the postwar trend of aviation from the point of view of the individual.

Research Department, The Crowell-Collier Publishing Company, New York, 1944; 70 pages, $0.25.

Papers on Rocketry

Members of the M.I.T. Rocket Research Society

Contents: "Subsonic and Supersonic Flow in Rocket Design," condensation of a lecture delivered by Dr. Emmons of Harvard to the M.I.T. Rocket Research Society by Edward Doyle; "Methods of Control for Rocket Propelled Aircraft" by Robert Fauvre; "Energy Relations in Rocket Propulsion" by Professor M. Rauscher with supplementary notes by John Fischer; "Rocket Propellants" by John H. Pomeroy; "Methods of High Temperature Measurement" by Robert B. Smith; "Refractories for Rocket Motors" by Robert B. Smith.

This collection of papers containing information about rocketry was prepared for the guidance of members of the Massachusetts Institute of Technology Rocket Research Society. The material was gathered from various sources, which include library references, discussions with local authorities, certain private publications, and original research.

An editorial board composed of officers and members of the Society briefly reviewed each report. The editors state that it is expected that the data and methods examined will become obsolete as knowledge is accumulated, but, until suitable textbooks on rocketry exist and the various experimental possibilities have been explored, these papers should have practical value. Massachusetts Institute of Technology Rocket Research Society, Cambridge, Mass., 1944, Publication No. 3; 41 pages, $1.00.

Instrument Flying and Radio Navigation

Holland L. Redfield

Contents: The Four Fundamentals and a Brief Review of the Theory of Flight; Flying the Four Fundamentals with the Primary Flight Group of Instruments; Combining the Four Fundamentals; The Artificial Horizon and the Directional Gyro; Radio; Bracketing and Following the Radio Range on Course; Locating the Range Station; Radio Range Orientation Systems; Radio Range Let-Down Procedures; The Radio Direction Finder; Homing and Position Plotting; The Link Trainer and the 1-2-3 System of Instrument Flying.

The author is an air-line flight instructor, and the method of instruction, which is simple and systematic, is a direct outgrowth of experience in teaching pilots, ranging from those with no experience in flying by instruments to seasoned air-line captains perfecting their techniques and keeping abreast of the latest methods. The method continues directly from the techniques the pilot has already acquired in contact flying. The author shows why adhering to basic fundamentals removes much of the difficulty of attempting to learn by some of the older methods, which the speeds and stability of today's aircraft have made obsolete. Radio-range and direction-finding navigation are clearly discussed in easily understood language.

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Pointers are given that should save considerable time in attaining proficiency. The Ronald Press, New York, 1944; 195 pages, $3.00.

Methods of Advanced Calculus

Philip Franklin

Contents: Elementary Functions for Complex Values and Taylor's Series; Partial Differentiation and Implicit Functions; Vectors, Curves, and Surfaces in Space; Integration, The Definite Integral Multiple Integrals; Line Integrals, Complex Variables; The Gamma Function and Related Definite Integrals; Elliptic Integrals; Vector Analysis; Differential Equations; Legendre Polynomials and Bessel Functions; Fourier Series and Partial Differential Equations; The Calculus of Variations and LaGrange's Equations.

A textbook on advanced calculus suitable for a course of the type now being taken by students whose major field of interest is engineering, mathematics, or science. The book is also suited to those who wish to refresh and improve their technique in applying elementary calculus. It is therefore of value as a reference book for practicing engineers and applied scientists who require a stepping stone to more specialized mathematical treatises. The reader is assumed to have a working knowledge of calculus, but no greater facility is needed than that usually acquired from a first course in the subject. The earlier chapters deal with topics touched on to some extent in elementary calculus, while later chapters deal with special higher functions. McGraw-Hill Book Company, Inc., New York, 1944; 486 pages, $4.50.

Engineering Inspection Practice

A. T. King

Contents: Reading the Working Drawing; Limits and Tolerances; Linear and Angular Measurement; Arithmetic and Mensuration Revision; Trigonometry; Hand-Measuring Tools; Micrometers and Micro-measuring Instruments; Limit Gauging and Gauges; Measuring Screw Threads; Angular Measuring Instruments; Gear Measurement; Precision Measuring Tools and Machines; Engineering Materials; Engineering Hardening Processes; Mechanical Testing of Materials; Hardness Testing; Aeronautical Inspection.

A course in modern methods of engineering inspection, including aeronautical inspection. Information is furnished about the methods, gauges, and instruments used in engineering production workshops. The guide is intended for subcontractors and small manufacturers who now employ precision methods previously limited to large-scale manufacture, and for the many individuals who are training for specific jobs of inspection. The best modern practice is described in easily understood language.

Subjects dealt with in the chapter on aeronautical inspection include the classification of steels; the inspection of aircraft timber, plywood, and wood propellers; coating, riveting, and welding processes; and the determination of proof tests. Chemical Publishing Company, Inc., Brooklyn, 1944; 242 pages, $3.00.

Military and Commercial Aircraft Hydraulics

Raymond N. Greif

Contents: Elementary Hydraulic Systems—Basic Units; Complete Hydraulic Systems—Basic Units; Miscellaneous and Specific Units; Description of Typical Hydraulic Systems; Maintenance of Typical Hydraulic Units; Trouble Shooting, Hydraulic Fluids; Hydraulic Plumbing.

Theoretical and practical knowledge required by mechanics specializing in the maintenance of aircraft hydraulic systems is given in this book. The author first presents a description of working systems with their component units. Individual units of the system are then described in detail. This is followed by information about how the system works in conjunction with other units.

The book has been written to serve as a general text for aviation schools, as a reference book on hydraulics and hydraulic equipment, as a home-study course for the apprentice mechanic, and as a trade manual for those already employed as hydraulic mechanics. It may also be used as a medium for acquainting private aircraft owners with the various elements that make up a hydraulic system. Pitman Publishing Corporation, New York, 1944; 113 pages, $2.00.

Naval Air Navigation for C.A.A. War Training Service Schools

Kent Collier, Lawrence Littlefield and Charles R. Shields

Contents: Introduction; General Method and Procedure in Solving D.R. Navigation Problems; Explanation of the Log Sheet; General Information Used in Problem Solution; Using the Mark 8 Computer; Types of Searches (Given Distance); Types of Searches with Time Given; General Vector Plotting Sheet Informaion; No Wind (Air) Position; Radio Fixes and Related Topics; Climb Procedure, Wind Stars and Drift Angles.

A text written especially to serve as a study and reference guide for cadets taking the Civil Aeronautics Administration war training course in naval dead-reckoning navigation. In writing this book the authors' object was to include all the necessary materials and procedures pertinent to this particular phase of the cadet's training. Because naval dead-reckoning navigation requires both an adequate background in the subject and the ability to perform certain operations mentally and mechanically, the authors have compiled a book that can be used as both a study and reference guide for these problems. The materials and procedures outlined have been used in the course given at the University of Kansas. Aeronautical Engineering Department of the University of Kansas, Lawrence, Kan.; 124 pages.

Notes on Helicopter Design Theory

Alexander A. Nikolsky

Contents: Review of Airscrew Theory; The Helicopter in Vertical Flight; Introduction to Flapping and Feathering; Forward Motion; Performance Calculations; Applied Loads on the Blades; Static Stability.

A series of lectures on the theory of helicopter design, given during a 4 weeks' course presented at Princeton University to a group of engineers representing the U.S. Army Air Forces, the U.S. Navy Bureau of Aeronautics, and a number of aircraft manufacturers.

The notes do not constitute a textbook, but have been published in response to requests from those who thought they could benefit from the survey of the data presented. Princeton University Press, Princeton, N.J., 1944; 228 pages, $3.00.

Book Notes

Prelude to Invasion, by Henry L. Stimson; Public Affairs Press, Washington, D.C., 1944; 332 pages, $3.25.

For an accurate running account of the military progress of the war from December 11, 1941, to June 8, 1944, this compilation of the reports issued by the Secretary of War will be used for reference by those who wish to secure an overall view of the accomplishments of the Army.

Mr. Stimson gives full credit to the Air Forces for the outstanding part they have taken in the strategic and tactical operations on all fronts.

General "Ike" Eisenhower, by Delos W. Lovelace; Thomas Y. Crowell Company, New York, 1944; 140 pages, $1.75.

The life story of the Commander in Chief of the Allied forces in the European area is one that is typical of American life. As he is also in command of the air forces of England and the United States, a familiarity with his back-

ground and his life story will be helpful to any airman.

Bomber Pilot, by Philip Harkins; Harcourt, Brace and Company, Inc., New York, 1944; 229 pages, $2.00.

This story follows the career of an aviation cadet from his home in Tennessee, through his period of training, to his sorties over Germany. The human side of the life of a trainee is emphasized to make this book attractive to boys and to stimulate their ambition to become pilots.

It recounts with great detail what flying feels like and what happens during combat operations. The attitude of the young pilots toward their new profession is shown by the many exchanges of wit, sarcasm, and humor so typical of the flying personnel of our Air Forces.

Fighting Words, edited by Warfield Lewis; J. B. Lippincott Company, New York, 1944; 330 pages, $3.00.

These stories differ from the usual run of war tales in that they were selected as prize winners in a contest among members of the armed forces, by a critical group of judges. The judges chose the stories by the process of elimination on the basis of personality of characters, plot, and style.

Outstanding is "Last Flight" by Pvt. G. Van Vlack, Jr., who writes of a student pilot who was declared unfit for further training. As a last fling he took a night flight without permission and after having his thrill landed the plane safely without any one at the station knowing of his escapade.

There are also reproductions of many cartoons, selected by another committee. They give a cross section of the sense of humor of the service men.

Pinellas County Airport, Pinellas County Aeronautical Advisory Commission, St. Petersburg, Fla., July, 1944; 48 pages.

A booklet that gives extensive information about Pinellas county's master airport and other airport facilities of that county and the surrounding counties on the west coast of Florida.

The second section of the publication contains a survey of the commercial and industrial facilities of the region, with particular attention to air-transport potentialities. Both sections of the booklet contain considerable statistical data relating to the business possibilities of the territory.

Infantry Attacks, by General Field Marshal Erwin Rommel; translated from the German by Lt. Col. G. E. Kidde; Ludwig Voggenreiter Verlag, Potsdam, 1937; published and distributed in the public interest by authority of the Alien Property Custodian, by *The Infantry Journal*, Washington, D.C., 1944; 265 pages, $3.00.

A translation of *Infanterie Greift an*, written by Erwin Rommel when he was a Lieutenant Colonel in the German Army, and published in Germany in 1937. It is a continuous narrative of his military experiences in the first World War, divided into three main parts. The first part deals with the war of movement, based on action in Belgium and northern France in 1914; the second refers to trench warfare in the Argonne and the High Vosges; and the third tells of open warfare in Rumania and the Carpathians in 1917.

Field Marshal Rommel came so near to victory in Africa that an examination of his methods will be of interest to every soldier who wants to know how leaders have acquired their skill. As a lieutenant in the first World War Rommel came up the "hard way." This is an account of his experiences, with a critique of each operation.

The most significant omission is any reference to aircraft cooperation, which indicates the great progress the airplane has made in warfare in the 26 years since the close of the war of 1914–1918, and even since the date of publication of the book.

Sea Duty and Other Stories of Naval Action, by Jacland Marmur; Henry Holt and Company, New York, 1944; 168 pages, $2.00.

For those who go down to the sea in warships this series of stories of naval engagements will be of great interest. The narratives are written in the terms of the men who fight, and disclose the human drama of their lives.

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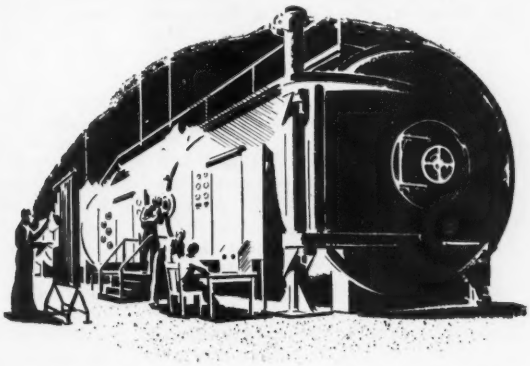
Will Aviation Progress Slacken in Peacetime?



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Elektrische Flugzeugausruestung (Electrical Equipment for Airplanes), by Bruno Klinker; Verlag Walter de Gruyter & Company, Berlin, 1942; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 135 pages, $5.25.

The principal aim of this book is to acquaint those who are interested in the development, production, and operation of airplanes with the part played by electric power in the equipment of modern aircraft. It is also the author's intention to make the special requirements more understandable by a detailed presentation of the conditions of operation. He does not attempt to give a description of all the instruments, but he has selected examples in such a manner as to offer a broad view. In order to promote an interchange of ideas and experiences the book gives a brief review of the particulars of the development of aircraft instruments, intended for those branches of the electrical industry not directly connected with the manufacture of instruments.

The principal sections of the text discuss the use of electric power in airplanes, principal requirements, current supply, and electrical installations aboard airplanes.

Die Wechselfestigkeit Metallischer Werkstoffe (Alternating Strength of Metals), by Wilfried Herold; Verlag von Julius Springer, Vienna, 1934; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 276 pages, $7.25.

It is stated that the development of modern technique requires lightweight construction in combination with complete safety of operation. This means utilization of the materials up to the permissible strength limits. If the designer wishes to meet these requirements, a general schematic treatment, according to the three load cases, is no longer sufficient. He must know exactly what actual stresses are taking place, as required by accurate strength analysis. This analysis is based on the knowledge of the characteristics of materials under static and alternating stress, and also on the actual course of the stresses.

This book deals mainly with the first problem, while the second is only slightly touched upon. In order to enable the designer and technician to get the benefit of previously published research work concerning vibration stresses on materials, the most important investigations in this subject have been systematically compiled in this book.

Technische Dynamik (Technical Dynamics), by C. B. Biezeno and R. Grammel; Verlag von Julius Springer, Berlin, 1939; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 1,056 pages, $27.80.

This book presents static and kinetic problems as they are experienced in technical mechanics. The authors took into consideration that a technical problem is worth solving only if it has practical value. They gave special attention to the methods of solution and developed them in complete detail in the same manner as any engineer would actually do it in practice. The selection of the problems was made with a special but not exclusive view toward the problems of engine design, particularly automotive engines.

Because it was not expected that the information contained in the book could be absorbed in a single reading, each chapter is self-contained. The book is divided into four main sections designated as principles, individual machine parts, steam turbines, and combustion engines.

The first section contains chapters on principles of elastomechanics, general theorems of elastomechanics, and solution methods. The second section includes rods and shafts, springs and rings, plates and shells, and stress problems. In the third section are chapters on rotating discs, steam-turbine blades, and critical number of revolutions. The fourth section deals with mass interchange, performance interchange, and torsional vibrations.

Technische Physik der Werkstoffe (Technical Physics of Materials), by C. Zwikker; Springer-Verlag, Berlin, 1942; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 230 pages, $8.50.

Within the limited space of this book the author gives a summary of old and modern views on the nature of solid bodies. Because of the limited size of the book and the great breadth of the subject covered, he had to curtail the selection of the problems to be discussed and solved. Experimental methods are omitted. Mathematical calculations are presented only to the extent that they are necessary to form the physical train of thought required to follow the text.

The book is divided into ten principal sections, as follows: Elementary Forces; Structure of Solid Bodies; Anisotropy; Electricity; Mechanical Vibrations; Thermal Properties; Properties Dependent on Structure; Transformations; After-Effect and Damping; Electronic Properties. Each section contains from seven to 17 short chapters discussing the different aspects of the main subject.

Turbulenz, Physikalische Statistik, und Hydrodynamik (Turbulence, Physical Statistics, and Hydrodynamics), by Hans Gebelein; Verlag von Julius Springer, Berlin, 1935; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 177 pages, $4.00.

According to the author, this book is the result of research work on the turbulence problem that he started in 1932 under Professor Prandtl in Goettingen. The purpose of the research was to develop hydrodynamic theory in such a way as to include the phenomena of turbulence. This was done by the application of statistical conclusion methods used heretofore with great success in many branches of physics. Therefore, in the investigations presented in this book hydrodynamics appears as a branch of physical statistics.

The sections of the book are titled: Elements of the Calculation of Probabilities; Classical Mechanics and Physical Statistics; Application of Physical Statistics to Flow Phenomena and Classical Hydrodynamics; Kinetic Theory of Gases and Navier-Strokes' Hydrodynamics; Theory of the Turbulence Tensor and Static Hydrodynamics; Turbulent Flow in Circular Tubes; Special Problems of Turbulent Flow; On the Importance of the "Time of Delay" on Physical Statistics.

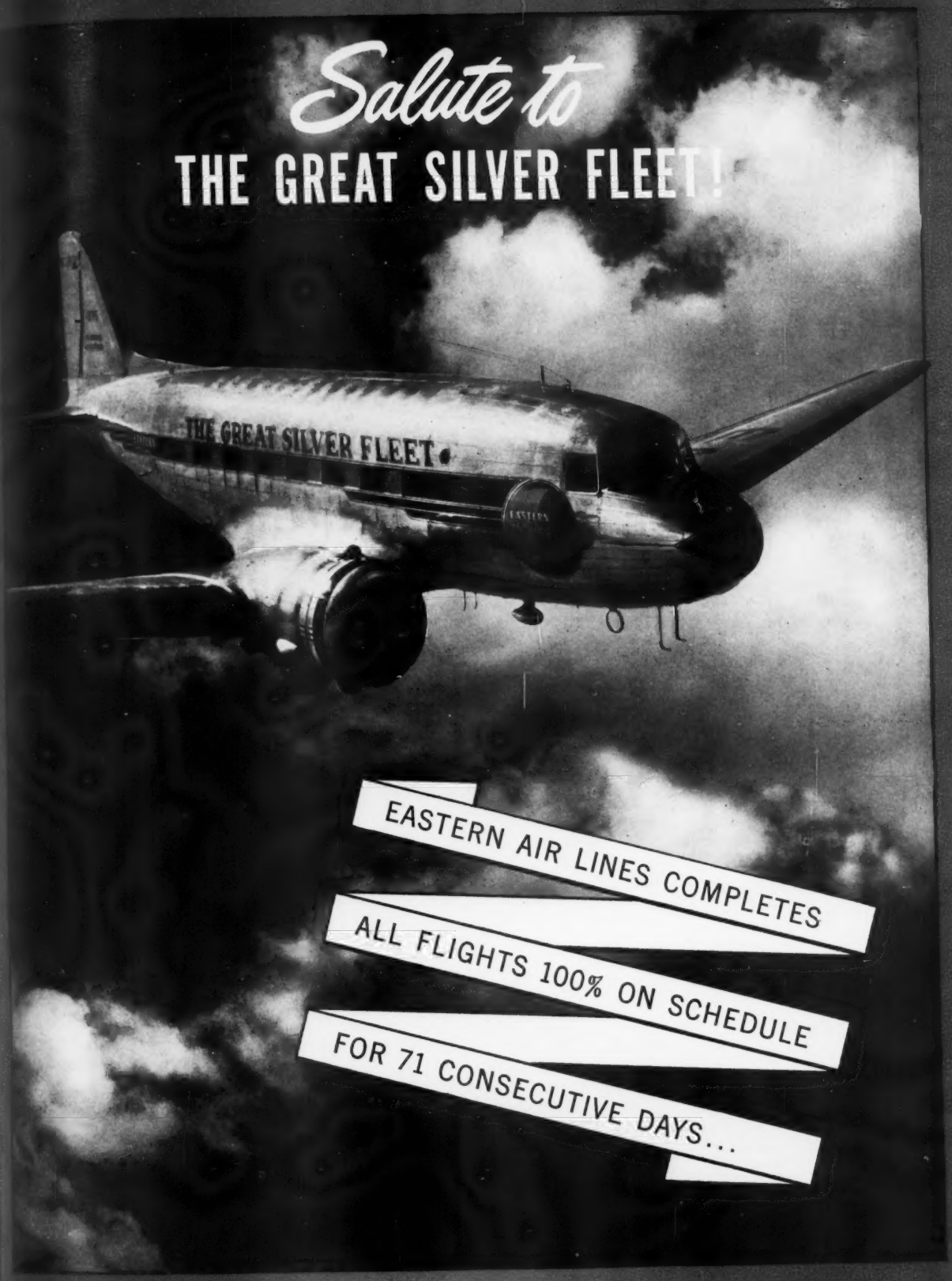
Berechnungsverfahren zur Bestimmung der kritischen Drehzahlen von geraden Wellen (Calculation Methods to Determine the Critical Number of Revolutions of Straight Shafts), by J. J. Holba; Verlag von Julius Springer, Vienna, 1936; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1943; 190 pages, $4.10.

A compilation of recent methods for the calculation of the critical number of revolutions of a shaft. The author states that no detailed presentation of such calculation methods applying to this branch of dynamic mechanics, with reference to bearing loads and other related conditions, has been available previously. Such information is considered to be valuable for the engine designer who is required to give careful attention to such conditions, which may be liable to cause trouble for purely physical reasons.

Schmierstoffe und Maschinenschmierung (Lubricants and Engine Lubrication), by Erich Herwig Kadmer; Verlag von Gebrueder Borntraeger, Berlin, 1941; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 507 pages, $8.50.

The author, a chemist, attempts not only to present this technical subject in a manner understandable to the lay reader, but also brings the subject up to date by the inclusion of the latest achievements of science. He gives information about the chemical composition of lubricants, their manufacture, the properties and designations of various grades, with reference to viscosity, flash point, color, reflection and disbursion, specific heat and heat conduction, distillation, molecular weight, and many other characteristics.

The various sources from which lubricants are obtained, such as natural petroleum, fats, acids, graphites, synthetics, and others, are outlined. Proc-



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Eastern writes a new page in Airline History!

New York Times Editorial—August 4, 1944

AIRLINE PERFORMANCE

Spectacular accomplishments by bombers and fighters have brought us some realization of the startlingly swift advances which have been made under the stimulus of war in the range, speed and reliability of aircraft. Combat reports have tended to overshadow, however, the correlative advances which are being made in commercial air transport. The airlines, not only in their function as aids and operators for the armed services in a great network of global flying, but in their domestic operation, have taken great forward strides during the war years. With reduced fleets and personnel, they still have been able to set new marks in passengers, mail and goods carried, and in the performance of schedules. Eastern Airlines, for example, has just established a record not heretofore equaled in commercial air transport history, flying all its schedules with 100 per cent performance for the two consecutive months of June and July. During these months the line's "silver fleet" flew 43,000,000 revenue passenger miles in domestic operations alone, while its cargo liners averaged about 20,000,000-pound miles a day.

This performance and that of the other air carriers, which are showing load factors and percentage of airplane use per day which would have been deemed incredible only a few years ago, indicate the expanded air service for which we may look in the days of peace.

TO TIE OR NOT TO TIE

Never was there a day when it was so vitally important to the nation that high-priority air travel move swiftly to its destination . . . that increased loads of air cargo arrive in plenty and on time.

The achievement of Eastern Air Lines in completing all flights 100% on schedule for 71 consecutive days in the face of capacity loads and with daily flying time of every airplane almost doubled over prewar days is a record that in the words of the New York Times editorial of August 4, 1944, "not heretofore equalled in commercial air transport history."

With a fleet reduced 50%, Eastern has equalled and even exceeded prewar records of passengers and cargoes delivered. With each Silverliner in the air an average of 14 hours and 7 minutes every day, Eastern Air Lines maintenance men are doing a greater, more important job than ever.

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AND THEY DID THIS JOB BY

Check, Double Check...and Triple Check

Courtesy of Curtiss-Wright

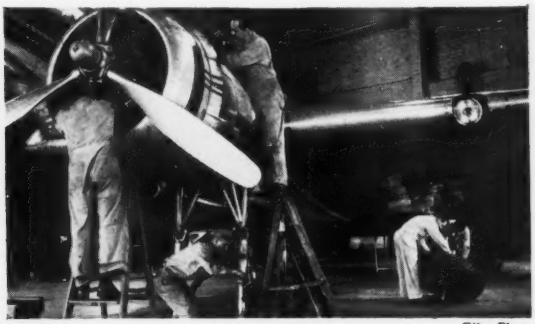
Station Control Board for Maintenance . . . Upon this board is recorded every maintenance service that must be performed by the ground crew before a plane can be cleared for its next flight.

Giles Photo

Station Check . . . At the end of every trip, Eastern Air Lines ground crews check engines, engine and flying instruments, radio equipment, controls, propellers, tires and brakes.

Courtesy of Curtiss-Wright

Terminal Check . . . The basic station check is repeated plus inspection of electrical, ventilation and air conditioning systems, gasoline and oil strainers and valves. Plane and upholstery are cleaned.



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Base Check . . . This is a complete check-up of the entire plane. Engines, propellers, radio controls, landing gear are inspected with special attention to condition of wheels, brakes and tires.

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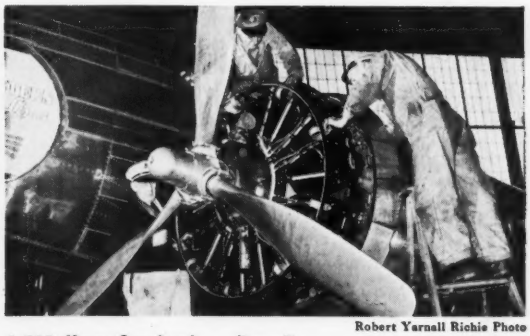
650 Hour Check . . . Wheel assemblies are now removed for overhaul. This includes demounting the tire for complete inspection of both tire and tube. Special attention is also given bearings and brakes.



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6,500 Hour Overhaul . . . Propellers, engines, electric and radio equipment, lubricating systems, wheels, brakes, tires and all accessories are disassembled and carefully checked before return to service.

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Never having had a passenger fatality during its entire operating history, 1930-1936 with an accumulation of 141,194,694 Passenger Miles
This, according to the U.S. Department of Commerce records is the best Air Transport accomplishment to date.
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635,000,245 Passenger Miles
without a passenger or crew fatality

FIRST SAFETY AWARD—In 1937 the National Safety Council instituted the Aviation Safety Award for Safe Air Transportation. On its record of no passenger fatalities in its entire operating history (1930-1936) Eastern Air Lines won this award. The certificate states, "This, according to U. S. Department of Commerce records is the best Air Transportation Accomplishment to date."

LATEST SAFETY AWARD—Other awards followed and again in 1944 Eastern Air Lines won the National Safety Council Award for commercial air lines operating 100,000,000 passenger miles or more annually. Their record for safe air transportation for the period ending December 31, 1943 totaled 635,000,245 passenger miles without a passenger or crew fatality.

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esses of refining are described in detail.

The application of lubricants to the individual parts of machines is discussed, as well as devices for conducting the lubricants to the parts and surfaces to be lubricated. The book refers primarily to general industrial machinery, but a chapter is devoted to a discussion of the lubrication of aircraft engines.

Kerbspannungslehre (Notched-Bar Strength Theory), by H. Neuber; Verlag von Julius Springer, Berlin, 1937; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 160 pages, $4.00.

The purpose of this book is to present a practical stress theory based on a thorough theoretical investigation of materials. The author states that results published so far are derived from experiments. These experiments deal only with individual cases, whereas it is his opinion that valid generalizations are needed.

In the opening chapters the principles of the notch effect and the stress theory are explained. The theories of the effect of the different types of notches—two- and three-dimensional, prismatic reduction, and pointed notches—are discussed in following chapters. The concluding sections of the book give comparisons of the theoretical treatment with the results of experimental investigations of stresses, and nomograms on characteristic numbers.

Die Grundlagen der Waermeuebertragung (Principles of Heat Transmission), by Friedrich Merkel; Verlag von Theodore Steinkopff, Leipzig, 1927; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 234 pages, $4.90.

The author gives available theoretical and experimental research results on heat transmission in an effort to make them suitable for practical use. The detailed statement of the theoretical principles is intended to give a clear conception of the physical nature of the various phenomena.

Because of the great importance of the subject in practice, a large part of this book has been devoted to heat transmission between solid walls and fluids or gases. In order to facilitate numerical calculations, special consideration has been given to the graphic representation of the most important formulas. The scale of the diagrams is arranged in such a way that interpolation may be made easily and accurately by means of a millimeter rule.

The main sections of the book refer to pure heat conduction in solid bodies, heat transmission, heat radiation, heat passage, and values of the most important materials.

Chemische Physik der Metalle und Legierungen (Chemical Physics of Metals and Alloys), by Ulrich Dehlinger; Akademsiche Verlagsgesellschaft M.B.H., Leipzig, 1939; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 174 pages, $4.25.

This book is intended to give a comprehensive, exact, and clear picture of conditions and reactions in metals and alloys, as well as their causes. According to the author, modern metallurgy has, in some respects, reached a rather unusual position. On the one hand, many practical experiences have been gathered, and yet the science is far from classic perfection. On the other hand, it is concerned with chemistry, physics, mineralogy, and technology. Therefore, the chemist and technician may find too much of physics and mathematics in this book, while the physicist will miss a discussion of precision measurements and complicated calculations.

The three main sections of the book refer to research methods, equilibrium conditions, and kinetics.

Materialpruefung mit Roentgenstrahlen (Material Testing by Means of X-Rays), by Richard Glocker; Verlag von Julius Springer, Berlin, 1936; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 386 pages, $9.65.

The author reviews the three different properties of X-rays that form the basis of material-testing methods. These are absorption (macroscopic investigation of materials), spectral analysis, and bending in crystal lattices (microscopic investigation of materials). According to the book, about 15 years after X-rays had been discovered an investigation showed that they are bent when passing through crystals and are therefore of an electromagnetic nature. This test has been of the greatest importance for the future development of X-ray research, for it made possible the measurement of the wavelengths of X-rays, as well as the investigation of the atomic structure of crystals. The application of these methods is described in detail, complemented by many illustrations and tables.

Grundzuege der Schmiertechnik (Outline of the Lubrication Technique), by Erich Falz; Verlag von Julius Springer, Berlin, 1931; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1943; 326 pages, $6.60.

It is stated that there are so many contradictory and obscure views on lubrication that a clear presentation of the prevailing interpretation is almost impossible. The aim of this book is to present the outlines of the technique of lubrication in the light of modern knowledge, in a concise and understandable manner, as a guide for engineers. There is a brief, clear summary at the end of each chapter giving a general review of the subject matter of the chapter.

The sections of the book are: characteristics of perfect lubrication; general calculation principles; carrying capacity of perfectly lubricated sliding surfaces; friction conditions at perfect lubrication; lubrication methods, lubricants, and bearing metals; practical constructions and directions.

Lehrbuch der Ballistik (Textbook of Ballistics), by C. Cranz; Verlag von Julius Springer, Berlin; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; Vol. I, 1925, 711 pages, $24; Vol. II, 1926, 454 pages, $16.50; Vol. III, 1927, 408 pages, $15.50; Vol. IV, 1936, 292 pages, $11.

Three main volumes and a supplementary volume constitute this book. The titles of the main volumes are as follows: I, External Ballistics, or the Theory of the Motion of the Projectile from the Muzzle of the Gun to the Penetration of the Target; II, Internal Ballistics, or the Motion of the Projectile Within the Barrel of the Gun, and the Accompanying Phenomena; III, Experimental Ballistics, or Methods of Ballistic Measurement, Observation, and Recording.

In Vol. I calculations of the parabolic path of the projectile are given. Many problems and their mathematical solutions are stated in such a way that they may be followed easily, even by those who are not expert mathematicians. The main problem of Vol. II is the determination of gas pressure in the gun barrel, acceleration and velocity of the projectile, and temperatures of the powder gases, each as a function of time or of the course of the projectile in the barrel. There are some secondary problems relative to the heating of the gun barrel, to the effects of wear and tear on barrel and gun carriage, and to internal-ballistic measuring methods.

In Vol. III mathematical and physical measuring, observation, and recording devices and their practical application are described. The supplementary volume brings the information contained in the previous volumes up to date.

Physik der mechanischen Werkstoffpruefung (Physics of Mechanical Material Testing), by Wilhelm Spaeth; Verlag von Julius Springer, Berlin, 1938; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 179 pages, $3.90.

It is stated that there are two distinct material-testing methods, that is, the classical static load test and the modern dynamic fatigue test. Therefore, it becomes necessary to give critical consideration to the principal problems of material testing, in order to find a more solid basis for the endless number of individual observations and to indicate the points that static and dynamic tests have in common.

Statements in this book may deviate sometimes from what is custom-

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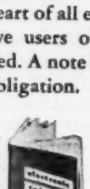

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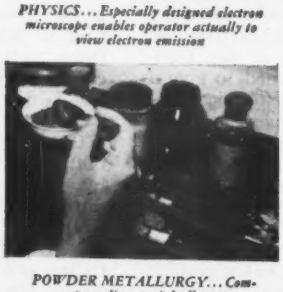
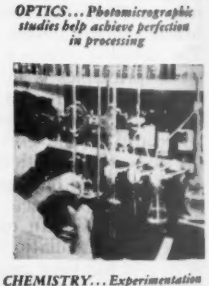
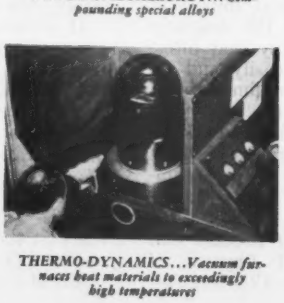


POWDER METALLURGY . . . Compounding special alloys



CHEMISTRY . . . Experimentation with metallic components and preparation of chemical compounds



THERMO-DYNAMICS . . . Vacuum furnaces heat materials to exceedingly high temperatures

ELECTRONICS . . . Determining facts about and recording data on vacuum tube capabilities

ary. Nevertheless, they help to point out the relations between various properties of materials whose interpretation from a few basic conceptions is desired. In this way close interrelations between static and dynamic tests are revealed; thus the danger that material testing may ultimately be split into two distinct trends is removed.

The various sections of the book discuss the characteristics of static load devices, the analysis of load-deformation diagrams, upper and lower yield limit, other yield phenomena, and the development of static testing machines. Other sections give information about equipment for dynamic tests, material damping, consideration of models, damping and strength values of materials, and the physical importance of the characteristic values of materials. The final sections contain instructions for making fatigue tests, and summarize the conclusions and requirements.

Kupfer im technischen Eisen (Copper Content of Technical Iron), by Heinrich Cornelius; Verlag von Julius Springer, Berlin, 1940; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 225 pages, $4.90.

The author has compiled a summary of a large number of published investigations of this subject, making it an excellent reference book. The first of two main sections deals with the uses of copper as an alloy with various grades of steel. One such application of interest to the aircraft industry is the addition of copper to high-carbon cast steel in the production of crankshafts, cylinder liners, brake drums, etc. The second section refers to the effects of copper content on the different types of cast iron.

Hochschmelzende Hartstoffe und ihre technische Anwendung (Heat Resisting Hard Materials and Their Technical Application), by Karl Becker; Verlag Chemie, G. M. B. H., Berlin, 1935; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 254 pages, $6.00.

This book deals with carbides, nitrides, borides, and their alloys. It describes their properties of high melting point, great hardness, metallic character, extreme conductivity, relatively high chemical resistance, etc., which make them materials suitable for extensive use in numerous industries. Their employment in the form of cutting tools has revolutionized many of the processes of machining. The author gives a detailed discussion of the various properties of these materials and of the methods by which they are produced.

Chemie und Technologie der Kunststoffe (Chemistry and Technology of Synthetic Materials), Vol. I, Chemical and Physical Principles, and Testing Methods; Vol. II, Production Methods and Properties, by R. Houwink; Akademische Verlagsgesellschaft Becker & Erler Kom.-Ges., Leipzig, 1942; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 448 pages, $20 per set.

The aim of these two books is to acquaint scientists, technicians, and students with the development of synthetic materials and with the problems pertaining to them. The first volume is devoted to general problems and deals with the chemical, physical, mechanical, and electrical principles entering into the manufacture and use of synthetic materials. It also discusses testing processes and the economics of the industry. Only organic synthetic materials are considered. The chapters of Vol. I are as follows: Organic Chemistry of Synthetic Materials; Kinetics of the Reaction of the Polymerization and Polycondensation Processes; on Molecular Weight of Macro-Molecular Compositions, and Its Determination; Physics and Colloidal Structure; Electrophysics of Synthetic Materials; Mechanical Methods of Treatment During Production; Grading and Standardization of Synthetic Materials; Testing of Films and Threads; Mechanical and Physical Strength Tests of Synthetic Materials; Electrical Tests of Synthetic Materials; Chemical Tests of Synthetic Materials; Economic Status of the Synthetic-Material Industry.

The second volume is concerned with the production of the various synthetic materials and the sources from which they are divided. It contains the following chapters: Synthetic Materials with a Base of Phenol and Its Derivatives; Synthetic Materials with a Base of Carbamide and Aminotriazine; Synthetic Materials with a Phthalic Acid Base; Synthetic Materials Resulting from the Polymerization of Ethylene Derivatives; Synthetic Materials with a Cellulose Base; Synthetic Materials with a Base of Casein and Other Proteins; Polyamides; Synthetic Materials with a Rubber Base; Synthetic Rubber; Various Refined Natural Products; Tables of Physical and Chemical Data.

Schweisstechnik im Flugzeugbau (Welding Technique in Airplane Construction), by Kurt Queitsch; Dr. M. Matthiesen & Company, Berlin, 1941; Lithoprinted by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 160 pages, $6.55.

An elementary book on welding for beginners, as well as a manual for the advanced welder. The various welding methods and their application to ferrous and nonferrous metals are described. Practical welding hints are given for the construction of various airplane parts.

Schweisskonstruktionen (Welded Structures), by R. Haenchen; Verlag von Julius Springer, Berlin, 1939; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 123 pages, $4.15.

The purpose of this book is to instruct the young engineer and the designer who may not be acquainted with welding techniques in the modern methods for the computation and design of welded structural parts. The author gives descriptions of the various welding processes and their application to different materials, with particular attention to the preparation of the materials in such a manner as to obtain the most economical use of them and avoid waste.

The book is divided into four sections: (1) Principles of Production; (2) Calculation of Welding Connections; (3) Shaping of Welded Parts; (4) Finished Structures.

The publication of the book was a consequence of the German 4-year plan, which called for the most economical use of all metals, including iron and steel. One of the means of complying with this order was considered to be the application of modern welding techniques to the making of lightweight and strong structures.

American Air Mail Catalogue, 1943 Supplement; The Airpost Journal, Albion, Pa., 1943; 67 pages, $1.00.

The second supplement to the 1940 edition of the American Air Mail Catalogue is principally useful to those philatelists who have both the 1940 catalogue and the prior supplement. It contains information for stamp collectors regarding recent flights.

Handbuch der Spritzgusstechnik der Metallegierungen einschliesslich des Warmpressgussverfahrens (Handbook of the Die-Casting Technique of Metal Alloys, Including the Hot Press Casting Method), by Leopold Frommer; Verlag von Julius Springer, Berlin, 1933; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 686 pages, $26.40.

This book deals with the principles of the die-casting process and with those of the design of die-casting machines and forms. It also describes construction methods and gives information about construction materials and shop practice.

The first chapter discusses considerations of the inlet process, and the resulting most suitable methods of operation. Others contain dissertations about the die-casting form, the die-casting machine, and the arrangement of the form on the machine. The concluding section refers to die-casting machines in actual use, the alloys employed, and practical application of die casting. Formulas are assembled in an appendix.

Meet the Electron, by David Grimes; Pitman Publishing Corporation, New York, 1944; 120 pages, $2.00.

A series of semitechnical lectures on the electron and electronics, which were presented by the author. The subject is presented in a form which will be easily understood by nontechnical readers.

THE B-29

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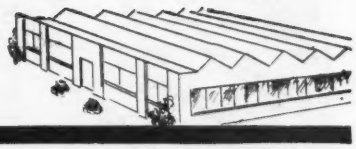

Opinions on Postwar Developments

Aviation Predictions. A conservative but optimistic picture of postwar developments in the aviation industry is presented in a compendium of recent predictions concerning the industry's probable future course. Compiled for the executives of Simmonds Aerocessories, Inc., the publication digests the publicly expressed thoughts of the heads of airplane-manufacturing companies; some of the country's leading aeronautical engineers; prominent air transport executives; aircraft research directors; statisticians specializing in aircraft production; Government officials in the Civil Aeronautics Administration, Army Air Forces, and the Navy Department; and officials of the National Resources Planning Board, the Aeronautical Chamber of Commerce, and others. The inclusion of figures demonstrating aviation trends and comments by individuals representing the industry's competitors lends balance to the weight of the predictions compiled in the brochure.

The discussion includes the probable number of privately owned planes in the postwar period, the likely cost of such planes in relation to the average American income, what the prevailing types of planes will be, predictions as to the future of the helicopter, and production costs on the basis of dollars and cents per pound-weight of plane. Other topics are future mechanical developments in aeronautics with special reference to safety factors, frank predictions on the handicaps that private flying must face and suggestions for overcoming them, the tie-in between bus lines and air lines, the speed of future planes, and future cargo transport, together with a detailed study of carrier costs and freight rates. The probable extent to which military planes will be converted to peacetime uses, future fuel costs, the place the glider will occupy, surface competition, jet propulsion, and future military aviation needs are some of the other subjects discussed.

Tables summarize the guesses as to production and use during the coming 10 years. It is a most useful compilation and will be welcomed as an aid to clarifying the minds of many as to the possible expansion of the aircraft field after the war. *Simmonds Aerocessories, Inc.*, New York.

Finishing of Engine Parts

Engine Parts Are Delicate Things; Even Finger Prints May Harm Them. This article is concerned with the importance of perfect surface finishing of engine parts. The possibility that a nick or a scratch in a highly finished part may bring about a fatigue failure with a speed far out of proportion to the size of the imperfection is demonstrated. Questions of how imperfections are caused and how they may be eliminated are considered. *The Wasp Nest*, September, 1944.

Specifications for Aircraft Metals

United States and British Commonwealth of Nations Aircraft Metals is a handbook prepared by the special U.S.-British Aeronautical Materials Specifications Committee as a result of discussions between representatives of the Society of British Aircraft Constructors, Ministry of Aircraft Production, British Air Commission, and the Society of Automotive Engineers. These discussions took place during the Summer of 1943 when representatives of the British organizations visited the United States. The Committee had the active cooperation of the Army Air Forces and the Navy Bureau of Aeronautics in the compilation of the data, which have been published as a part of the AN Aeronautical Handbook, AN 01-1A-9, for maintenance and repair. The information has been assembled in this booklet in order to make it available to the personnel of the aircraft industry.

It includes tables of specifications for aircraft metals classified under ferrous, aluminum, magnesium, copper, nickel, tin, zinc, bismuth, and lead alloys. Another set of tables contains chemical compositions and mechanical properties of the same list of alloys for aircraft uses. *SAE Aeronautical Information Report No. 8, Society of Automotive Engineers, Inc.*, New York.

Manual of Quality Standards

Quality Manual is the title of a ring-bound, board-covered manual, the purpose of which is to provide a source of information to promote uniformity of quality among member aircraft companies and their subcontractors and vendors. The subject has been treated in a manner intended to be helpful in the instruction of new personnel and at the same time to extend to all member companies the benefits of every other member company's experience. It is a reference manual and is not to be used as an authority or to supersede Government, commercial, or prime-contractor's specifications. Reference to specification numbers has been purposely avoided, and no effort is made to incorporate factory procedure.

Its chapters deal with inspection methods in each of 33 different classifications of aircraft manufacturing procedures, ranging from receiving inspection to the final steps of flight inspection and shipping inspection. *Aircraft War Production Council, Inc.*

Transport Planes Reconverted for Civilian Use

Johnny Comes Marching Home. Some brief notes about how the Douglas Aircraft Company, Inc., reconverts DC-3 planes returned by the Army back to their specifications for use as civil transports. The operations outlined as necessary for the reconversion job include reskinning, repainting, and rebuilding, together with the installation of engineering improvements that have been developed since the war started. *Douglas Airview*, September, 1944.

Hard-Facing Parts for Longer Wear

Cut Costs with Haynes Stellite Hard-Facing Rods. A new pamphlet has been issued about a hard-facing medium for re-enforcing worn machinery and equipment parts. Recommended particularly for welding shops, this pamphlet outlines the advantages of protecting wearing parts by hard-facing them with Haynes Stellite alloy. It lists typical parts that can be hard-faced in various industries and contains illustrations of some of these parts. *Haynes Stellite Company, Unit of Union Carbide and Carbon Corporation*, New York.

Financial Analysis of Air Lines

Airlines—1944. This is a recent financial study of the air lines of the United States. It has been prepared by the analysts and economic specialists of the largest brokerage house in this country. After general comment about the air transport situation as it appears in 1944, there are sections dealing with existing air routes and possible postwar world airways, the nation's aerial assets in man power and machines, the growth of investment in air transportation, and sources of revenue.

This is followed by statements showing the status of each of the leading air lines. These figures are supplemented by graphs and charts and a general statement showing the current situation of each air-line company. *Merrill Lynch, Pierce, Fenner and Beane.*

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Bombing Japanese Steel Plants

Can the B-29 Smash Nippon's Steel Industry? Reynolds Phillips. An explanation of why the steel industry has apparently been selected as the main target in the B-29 attacks upon Japan. Analyzing her steel supply as one of the vulnerable points in Japan's ability to wage war, the writer reviews her attempt to increase steel production and decentralize it by establishing steel factories in Manchukuo. He then shows that, while the steel industry in Japan proper presents a ready target for bombing attack because of its intense concentration, factories in Manchukuo are also vulnerable to bombing because the operating range of the B-29s brings them within raiding distance. In addition to noting the difficulties of decentralizing steel mills in Japan, the writer also draws attention to the fact that the Japanese have been beset by production trouble in Manchukuo, which makes the steel factories in Manchukuo particularly liable to disruption by continued bombing. *Boeing Magazine*, September, 1944.

Shot Peening and Metal Fatigue

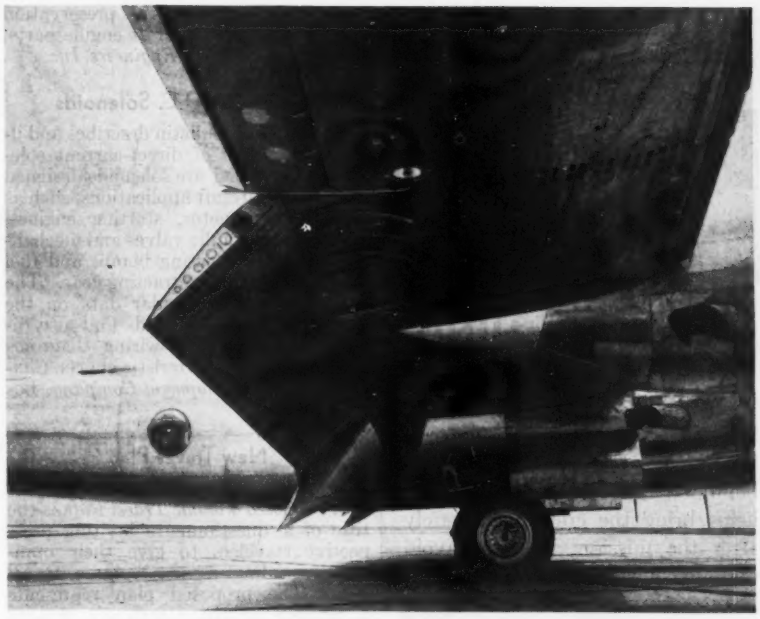
Shot Peening and the Fatigue of Metals, a technical paper by H. F. Moore, for many years Research Professor of Engineering Materials at the University of Illinois, has been published in booklet form. Among the subjects included are: types of structural damage of metals; how shot peening increases resistance to plastic distortion; the origin of fatigue cracks; the effects of cold working; measurement of shot-peening intensity; examples of increased fatigue life from shot peening; and many others. The booklet is illustrated by microphotographs, charts, and tables and contains research data that, it is stated, have never before been published. *American Foundry Equipment Company*, Mishawaka, Ind.

Shipping Mounts for Engines

Plywood Shipping Mounts for Pratt & Whitney Aircraft Engines Save Time and Labor. How the problem of packing and moving radial aircraft engines was simplified by the development of truncated cones made of plywood to which the engines could be bolted is described in this article. Requirements that had to be met in developing these mounts are enumerated as low weight, maximum strength, rigidity, ease of fabrication, and economy of material. The special bonding method devised for the manufacture of these engine mounts is described. *The Resinous Reporter*, September, 1944.

Tool Manufacturers

Sheffield Contract Services. A 16-page brochure contains information about the contract service of the Sheffield Corporation. Data on company procedures, facilities, and equipment are included in the account of the services that are available in connection with the design and manufacture of machine tools and production equipment. *The Sheffield Corporation*, Dayton, Ohio.



The Boeing B-29 high-performance wing. The huge flap is responsible for excellent landing and take-off characteristics. Nacelle tip prevents air turbulence.

Booklet on Radio Compass

The Radio Compass is the title of a booklet that describes how this instrument aids the aircraft pilot in flying his course safely. A simple, non-technical description of the radio compass and the way it was developed is also given. Diagrams and illustrations are provided to clarify the subject. *Bendix Radio Division, Bendix Aviation Corporation*, Baltimore.

Superfortress Propeller

"Target—Tokio." Together with some design data about the Superfortress' propeller, information is given about methods and machinery that were developed for the manufacture of this component. Engineering problems that are noted were those met by Hamilton-Standard, designers of the propeller; manufacturing techniques and equipment are those of Frigidaire Division of General Motors, licensee of Hamilton Standard. Procedures mentioned include special fitting, tightening, and counterbalancing operations. Among the machines described is one for checking airfoil contours and another for checking the spider on which the entire hub assembly is built. *The Bee-Hive*, July-August, 1944.

Powdered Metal Bearings

Oilite Powdered Metal Products. A catalogue containing 168 pages makes available in convenient form information about powdered-metal bearings and parts for various industries. A brief description is given of the various types of powdered-metal bearings and how they are manufactured. Charts show their performance characteristics. A large section of this catalogue is devoted to tabulated data on the dimensions of stock plain bearings, flange bearings, and thrust bearings. *Chrysler Corporation, Amplex Division.*

Data Book on Stop Nuts

Esna Data Book and Catalog. A data book and catalogue contains information about Elastic Stop nuts. Sections of the book, which incorporates 119 pages, refer to hexagon, anchor, and clinch nuts. The data given include dimensions, weights, load strengths, finishes, and part numbers. Descriptions of the various types of fasteners also are given. *Elastic Stop Nut Corporation of America*, Newark, N.J.

A.T.C. Test Unit

Assuring Safety in ATC. The functions of the Air Transport Command's Test Unit is described. As related, it is the job of this unit to compile long-range testing data on the cruising characteristics of every aircraft flown by the Air Transport Command. The Test Unit operates from the Army Air Base in Miami. *Plane Talk*, September, 1944.

S.A.E. Aeronautical Standards

New and revised Aeronautical Standards and Recommended Practices have been released. They are numbered *AS 6A*, *160*, *161*, *172*, *173*, and *181–186*, as well as *ARP 197*. They refer, respectively, to shipping instructions for aircraft-engine enclosures, propeller-shaft collars, lifting eyes, nuts, and caps. Standards *AS 181–186* deal with wheel and axle dimensions, and *ARP 197* gives

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recommendations for the preservation and packaging of aircraft engine parts. *Society of Automotive Engineers, Inc.*

Bulletin on D.C. Solenoids

This 32-page bulletin describes and illustrates a line of direct-current solenoids. Included are solenoids designed for various aircraft applications, such as retarding magnetos, starting engines, operating hydraulic valves and mechanical clutches, releasing bombs and fuel tanks, and locking retracting gear. The bulletin contains tabular data on the various types of solenoids and also dimensional drawings, wiring diagrams and response-characteristic charts. *Cannon Electric Development Company*, Los Angeles.

New Travel Plan

United Air Lines Invites Your Opinion on a Proposed Volume Travel Plan is the title of a questionnaire inviting prospective travelers to give their opinions regarding a new volume travel plan. The proposed plan represents a revision of the company's present travel plan, which permits individuals holding "air travel cards" to purchase transportation on credit. The new plan is stated to offer simplification and certain other advantages to subscribing companies as well as to the air lines. *United Air Lines Transport Corporation.*

Experimental Manufacturing Department of Propeller Plant

They Make It First. Supplemented by some brief descriptive data about the unit's activities, this is an explanation of the role played by the Experimental Manufacturing Department of Curtiss-Wright's Propeller Division in the development of new propeller components. It is the function of this department to build prototypes of new propellers and their components for preproduction tests. Entirely divorced from the Propeller Division's regular manufacturing facilities, this department is reported to operate as a self-contained unit. On a smaller scale, its organization and facilities correspond to those of a regular production plant. A chart of the department's organizational setup is included with the article. *The Bladesman*, September, 1944.

Spring Design

Springs Designed for the Job. A new 8-page booklet emphasizes the importance of correct spring design for aircraft, as well as other applications. It describes the four factors essential to designing a spring for correct specific purposes: (1) a thorough study of working conditions; (2) the use of the services of experienced spring engineers; (3) the choice of right material; and (4) the ability to fabricate a spring efficiently, regardless of intricate design.

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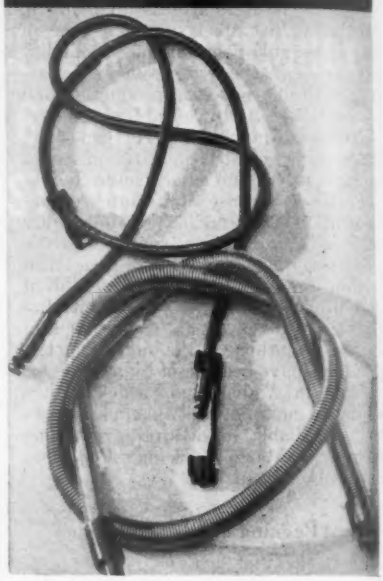

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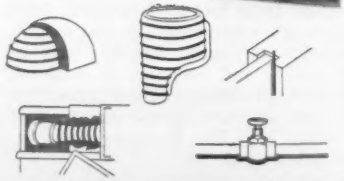

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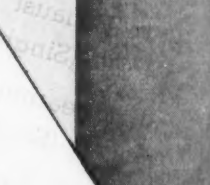

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signed. The brochure also details the characteristics of twelve of the commonly used spring materials and includes data about the specialized equipment necessary for producing a variety of spring designs. *Muehlhausen Spring Corporation, Division of Standard Steel Spring Company*, Logansport, Ind.

Aircraft Pumps

A New Design, Low Suction Loss, Rotary Pump. R. J. S. Pigott. A reprint in booklet form of a paper prepared for a meeting on altitude lubrication held at The Pennsylvania State College. It describes a new type of rotary pump for aircraft oiling systems and the research that led to a design with a low-suction loss. Photograph and diagrams of the pump are shown. The report is designated as *KG 00 (37)*, Engineering Division. *Gulf Research and Development Company*, Pittsburgh.

Electric Control Equipment

The Key to Modern Aircraft Controls. William P. Lear. A paper presented at the joint meeting of the Franklin Institute and the American Institute of Electrical Engineers has been reprinted in booklet form. It discusses remote and automatic electric controls for modern aircraft. Among the devices described are actuators, retraction units, positioning controls, magnetic clutches and brakes, selsyn-type signals, and preset positioning controls. The general theory of automatic controls is explained, and typical aircraft applications are outlined. Diagrams and cutaway illustrations are included to clarify the text. *Lear Incorporated.*

Global Delivery Service

Sending Them Overseas. This is an article on the organization and work of Consolidated Vultee's Foreign Delivery section. Under the jurisdiction of the corporation's Flight and Service Department, the Foreign Delivery section is charged with delivery of Consolidated Vultee planes to places all over the world. Requirements for members of the air crews who fly the planes to their destinations are noted. *Plane Talk*, September, 1944.

Hot Working of Steel

Hot Working Improves Properties of Metal. How the quality of metal is improved by hot-working is described in a 40-page booklet, which has been issued for those having to do with the metalworking industry. The booklet tells how steel gains progressively in strength and toughness as it is passed through hot-working operations from the ingot to the finished forging. *Technical Committee of the Drop Forging Association*, Cleveland.

Kron Scale Catalogue

Catalogue No. R-44 of Kron scales made by Yale describes the line of platform scales and special models for counting, batching, tensile strength, and dynamometer work. It is illustrated and contains specifications and dimensions of every standard Kron Scale. *The Yale & Towne Manufacturing Company, Philadelphia Division*, Philadelphia.

Radio Transmitters

A booklet has been issued describing the features of a transmitter, designated as FTR-3, which is suited to a wide variety of applications, including those in the aeronautical field. The equipment is intended for single- or multiple-channel radio telegraph or telephone service. It consists of three basic units, similar in outward appearance, which may be used in various combinations. These are a radio-frequency unit, an audio-frequency unit, and a power-supply unit. Specifications of the equipment are listed. *Federal Telephone and Radio Corporation*, Newark, N.J.

"Nine Mile High" Magneto

New Magneto Helps Fliers "Go Upstairs." Some brief information is given about the North East magneto for aircraft engines, designed and manufactured by the Delco Appliance Division. It is claimed that this magneto will function efficiently at all altitudes up to 50,000 ft., although it does not exceed conventional magnetos in weight, mechanism, auxiliary equipment, or service requirements. Several photographs depict how the device is produced and operated. *G. M. Folks*, September, 1944.

Electronic Induction Heat-Treating

Here's Help on Your Heat Treating Problems. A new job shop service specializing in electronic induction heat-treating is the subject of a 6-page folder. Besides describing the service, the folder cites the advantages of induction heat-treating. Those discussed are minimum distortion, minimum oxidation, maximum uniformity, controlled localization, controlled depth of penetration, speed, and economy. *Central Boiler and Manufacturing Company*, Detroit.

Disc-Clutch Maintenance

Installing and Servicing Pullmore Multiple-Disc Clutches is the title of a manual containing instructions on the installation and maintenance of multiple-disc clutches having capacities ranging from 1 to 90 hp. at 500 r.p.m. The instructions are for both single and double types of clutches for operation in oil or dry. These clutches may be used as main-drive clutches, as auxiliary clutches controlling individual units, and in power take-off mechanisms. A folder containing engineering data on these clutches has also been issued. *Rockford Drilling Machine Division, Borg-Warner Corporation*, Rockford, Ill.

Surface Roughness Gauging

Profilometer Comments, Technical Supplement No. 1. This folder describes the Profilometer, an instrument for measuring the surface roughness of materials that have been finished by grinding, milling, turning, and other methods. It is explained that the operation of this surface-roughness gauging instrument is based on electronic principles. Definitions of surface roughness are given, and the readings produced by the instrument are described. *Physicists Research Company*, Ann Arbor, Mich.

Plant Maintenance Section of Air-Line's Overhaul Base

Master of Many Trades. William L. Holly. The work of the Plant Maintenance Department of American Airlines' overhaul base at LaGuardia Airport is outlined. Duties of three different sections of the department are described. The first section is the electrical group; the second comprises the steamfitters, plumbers, and firemen group; and the third includes servicemen, carpenters, and painters. *Flagship News*, September, 1944.

Profile Grinder

The Sheffield Micro-Form Grinder is the title of a bulletin describing a grinding tool for the precision production of profiles direct from the drawing. It is explained that this grinder is designed to finish-grind all profiles within its range. It is suited for the grinding of both circular and flat-form tools, templates, profile gauges, cams, and dies from hardened materials, including tungsten carbide, and is not limited by the regularity or irregularity of the work. The 15-page publication is designated as *Bulletin No. M-120-144. The Sheffield Corporation*, Dayton, Ohio.

Rocket Launcher Tubes

Boom—Whi-i-ish!! This is an account of some of the operations seen by a visitor in a trip through a plant where extruded Dowmetal rocket-launcher tubes for aircraft are being manufactured. The writer tells how the visitor sees billets passed through the tempering oven and then automatically transferred to the extrusion press. What appears to be an endless tube is seen coming from the other end of the press. The tubing is sawed from the billet stub and is carried forward by a roller conveyer for further operations, which include sawing into sections, straightening, removing burrs, and inspection. Production operations are illustrated. *Dow Diamond*, September, 1944.

Comparator Charts

Screw-Thread Comparator Charts. A new folder has been issued on universal screw-thread comparator charts that are available for the entire series of both American National Fine-Threads, Class Two Fit, and Class Three Fit, and American National Coarse-Threads, Class Two Fit, and Class Three Fit.

It is noted that the elimination of duplicate charts has made possible the checking of from one to seven screw-thread sizes on individual charts. In-

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formation is also given about comparator charts for British Standard Whitworth threads. *Engineers Specialties Division, Universal Engraving & Colorplate Company, Inc.*, Cleveland.

Bonding Douglas Fir

New Douglas Fir Plywood Adhesive Announced. Attention is called to the development of Amberlite PR-83, a new phenolic adhesive especially designed for the bonding of EXT-grade Douglas fir plywood. The ideal qualities for a resin adhesive for Douglas fir plywood are listed. How the new adhesive meets these requirements is described. *The Resinous Reporter*, September, 1944.

New Lofting Method

Precision Lofting. A new brochure gives an insight into the industrial "lofting" method for producing, with accurate templates, a variety of products ranging from automobiles, aircraft, and household appliances, to small components. Basically, the method involves the mechanical reproduction of full-size detail drawings directly on tooling materials. Considerable manual duplication of scale drawings and manual transferring from blueprints to tooling materials are thereby eliminated, and substantial savings in time are made. *Template Reproduction Company*, Philadelphia.

"Pressure Pattern" Theory of Flight

TWA Pilot Revolutionizes Distance Flying Technique with New Theory. A new theory of avigation is interpreted. The flight technique based upon the theory devised by T.W.A. personnel is called "pressure pattern" flying. Its essence is to follow the contours of pressure areas in the wind streams when piloting a plane. Absolute altimeters help to determine the plane's position in relation to the pressure areas. *The Skyliner*, August, 1944.

Fifteen Years of Producing Aircraft Radios

Growth of a Company. The history of Lear Incorporated is outlined in a leaflet published by the company. Progress in the development of this aircraft-radio manufacturer's products and increases in sales, personnel, and facilities are traced from 1930. Some notes about contemplated projects for postwar years are included. *Lear Incorporated*, Piqua, Ohio.

Bulletin on Welding and Assembly Positioning Equipment

Bulletin No. 2151 describes in concise form the full line of Ransome welding and assembly positioning equipment. Photographs, diagrams, specifications, and important features of the positioners, as well as load-rating table, are included in the 4-page, two-color bulletin. *Ransome Machinery Company*, Dunellen, N.J.

Protective Coatings for Plating Racks

A new catalogue section on Koroseal Tape RX and Korolac RX, a solution of Koroseal, gives information about protective coatings for plating racks. The products were specially designed for plating-rack service and can be applied either separately or together.

Characteristics and properties of Koroseal and Korolac which make them suitable for this service are outlined in the catalogue section, together with illustrated instructions on how they should be applied. *The B. F. Goodrich Company*, Akron, Ohio.

Manufacturing Propeller Spinners

On the Nose. Some notes about the design and manufacture of propeller spinners. The notes are relative to the functions of a spinner, how they are designed and developed by the Spinner and Cuff Unit of the Curtiss-Wright Propeller Division's Engineering Department, and the manufacturing techniques employed by the Benson Manufacturing Company to produce them. Forming, annealing, and balancing procedures are mentioned. *The Bladesman*, September, 1944.

Drill-Press Turret Attachment

A bulletin describes a turret-head attachment for a drill press which makes it possible for multiple-spindle production work to be performed with a single-spindle press. With this attachment on the press, six consecutive drilling operations (such as spot-facing, drilling, counterboring, reaming, etc.) can be carried out without a change of tools. The booklet also offers engineering data on the turret head, an outline of available accessories, and installation and operation instructions. *Machine Development Company*, New York.

Quality-Control Booklet

Statistical Quality Control is a loose-leaf, paper-covered, mimeographed booklet containing a survey of the applications of statistical techniques for the control of the quality of manufactured products as practiced by various industries in the eastern part of the United States. It includes an analysis of the principles fundamental to successful use and a proposed system for application in the aircraft industry.

The report is divided into four principal parts. It is so arranged that a reading of the preface will enable the busy reader to go directly to the fourth section in which the system of statistical quality control for aircraft is suggested. The first three sections give specific details and verification of the statements made in Section IV, in case a more thorough study of the background for the procedure is desired.

Section I contains an analysis of the observations of the Committee. Section II is a summary of answers to a questionnaire, and Section III is a statement of principles fundamental to the organization and operation of quality control. *Aircraft War Production Council, Inc.*

Bulletins on Cementing Plastic Sheets

Information concerning cementing and welding of Plexiglas is summarized in two recent bulletins. One deals with the heat-welding of the material and the other with cementing it. The bulletins contain technical data and instructions for the operations involved, supplemented by sketches. *Rohm & Haas Company, Inc.*, Philadelphia.

Self-Sealing Rivet

"Trained Seal" Rivet. Information is given about a rivet devised by Boeing employees for the airtight sealing of the Superfortress's pressurized cabin. Obviating the need for using impregnated tape or brushing compounds, it is claimed that this invention will result in the saving of production time, money, and materials. The principle of the self-sealing rivet is based upon the employment of a small seal ring, notched right under the head of the rivet, which can be pushed into the rivet hole to fill up an irregularity. *Boeing Magazine*, September, 1944.

Catalogue of Lathes

Lathe Catalog No. 100-D features 21 full-color lathe illustrations and describes all South Bend engine lathes, toolroom lathes, and precision turret lathes. Engine lathes and toolroom lathes are shown in five sizes, ranging from 9 to 16 in. swing. There are two sizes of precision turret lathes—$^1/_2$ and 1 in. collet capacity, respectively.

Complete specifications are listed opposite each lathe illustration giving capacities, speeds, feeds, and dimensions. The remainder of the 68 pages and 75 illustrations is devoted to construction features of the lathe, lathe tools, and attachments for special classes of work. *South Bend Lathe Works*, South Bend, Ind.

Data on Lubrication

Shunt Type Lubrication System, Airplane Installation Tests is a preliminary résumé describing the work accomplished to date in the investigation of possible improvements in fuel-dilution procedures for winterized aircraft by the reduction in the amount of circulating oil. Information is given about the conditions under which the tests were conducted, and a table compares the approximate pump pressures under the standard system and the shunt system. A summary gives 8 possible advantages and 3 possible disadvantages of the system. *Allison Division, General Motor Corporation.*

New British Air Transport Bulletin

The C.I.A.T.O. Bulletin, of which the first issue bears the date of July, 1944, appears as the official organ of the Conference of International Air Traffic Operators. Its purpose is to serve as a link between the members of the organization and the headquarters.

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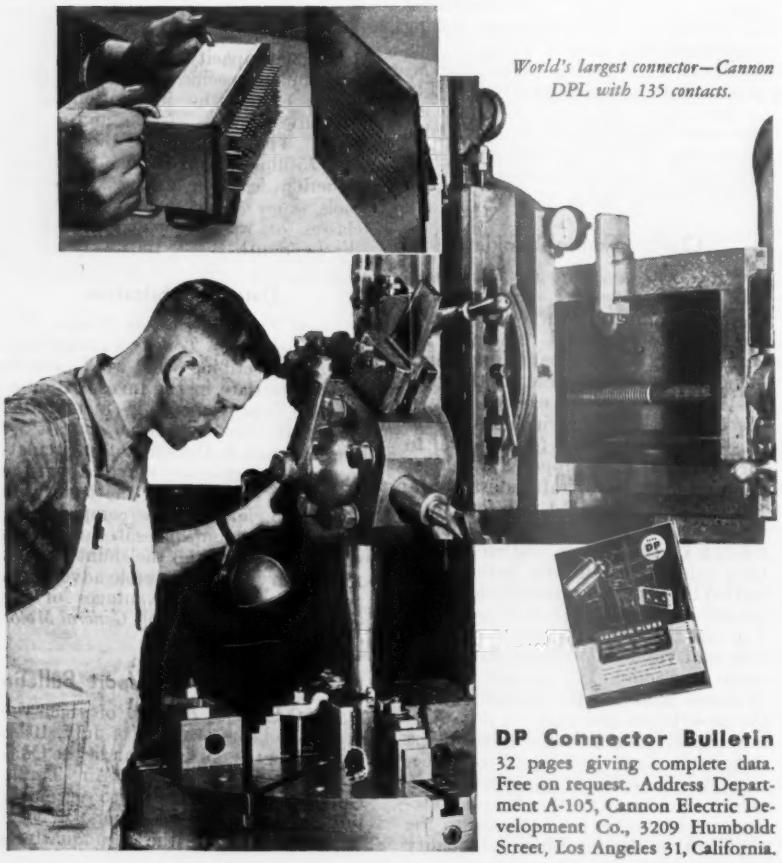

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Through it will be disseminated news of the organization and its activities, especially the decisions made by the Executive Committee, and of the work of the various other committees and study groups.

The introductory issue of the bulletin contains a message from Lord Londonderry about the importance of air transport, a message from the chairman of the Conference stating the aims of the Conference, the text of the interim constitution, and the names and connections of the officers and members of the Executive Committee of the Conference. *Conference of International Air Traffic Operators*, London.

Contributions of One Company to Air Transport Development

Pan American Firsts—1927 to 1944. In tabular form air transport developments pioneered by Pan American Airways are listed. The brief outline history covers the period from 1927 to 1944. *New Horizons*, October–December, 1944.

New Official Publication

Planes is a new official monthly publication, the first issue of which appeared in September, 1944. It is planned to carry the story of the problems and progress of the aviation industry to a selected list of editors, publishers, radio commentators, national, state, and local government officials, important industrialists, clergymen, schools and colleges, libraries, club officials, and other important community leaders.

The first number contains a brief summary of the air transport plans submitted to Congress by the Aeronautical Chamber of Commerce of America and various news items and statistics concerning the production, earnings, and efficiency of the aircraft industry. *Aeronautical Chamber of Commerce of America, Inc.*

Pioneer Publications

Several new publications have been issued about pioneer instruments. One is a booklet on the Remote-Indicating Magnesyn Compass System of the Marine Type. This is designed to acquaint the reader with the basic characteristics of the system and to present technical information regarding the installation, compensation, inspection, and maintenance of these units. It covers transmitter types 10066 1-A, 10068-1-B, and 10069-1-A; indicator types 10065-1A-A1 and 10070-1A-A1; and inverter box types 12119-1-A and 12119-2-A.

There are two Installation and Line Maintenance leaflets. The first of these, 43-1B, concerns autosyn oil or hydraulic pressure transmitters and supersedes No. 26-23A. The second is No. 44-21B, dealing with Inverters.

The three Service Bulletins are Nos. 45-10, 46-14A, and 46-21A (superseding 31-27A) and are devoted, respectively, to adjustment of the inverter for increased-load operation, re-

Sensenich Replacement Propeller List For Military Airplanes

Some Sensenich-equipped Liaison, Training and Utility Cargo airplanes originally purchased by the armed forces have already been sold to commercial operators and private flyers. There is every indication that more will be released in the near future. This list is published for the convenience of the purchasers to facilitate ordering replacement propellers.

AIRPLANE	MODEL	ENGINE MFGR.	ENGINE MODEL	HP	AAF DESIGN	SENSENICH DESIGN	NOTE
Aeronca	L3A, B, C, E, F, J	Continental	A 65	65	43K10107	72C42, 72C44	6
Aeronca	L3D	Franklin	4 AC 176 B2	65	72F42	72F42, 72F44	7
					72F44	72F42, 72F44	
Aeronca	L3G, H	Lycoming	O 145 B 2	65	70LY34	70LY34, 70LY36	7
					70LY36	70LY34, 70LY36	
Aeronca	PT-23	Continental	R 670 5	220	43K19181	90LA78	5
Boeing	PT-13 B, D, N2S-5	Lycoming	R 680 11	220	44K9705	98AA64, 98AA66	5
Boeing	PT-17, A N2S-3	Continental	R 670 5	220	44K9705	98AA64, 98AA66	5
					43K19593	98AA64, 98AA66	
Cessna	UC-78	Jacobs	L 4M B	225	707-80	90JA81	5
					43K13605	90JA81	
					44K26405	90JA81	
Fairchild	PT-19A, B	Ranger	6 440 C2	180	42K15729	86R61	1
					43K15131	86RA61	5
					43K15131A	86RA61	5
					43K26463	86RA61	5
					44K10817	86RB61	2
					44K10817M	86R61	1
Fairchild	PT-26	Ranger	6 440 C5	200	Same as PT-19A		
Fairchild	UC-61, A	Warner	Super Scarab	165	43K13397	86CB69	2
					43K14699	86CA69	1
Fairchild	UC-61K	Ranger	6 440 C 5	200	86AB54	86AB54	2
						86AA54	1
Fleet	PT-19A	Ranger	6 440 C 2	180	See Fairchild PT-19A		
Fleet	PT-23	Continental	R 670 5	220	43K19181	90LA78	5
Fleet	PT-26	Ranger	6 440 C 5	200	See Fairchild PT-19A		
Grumman	OA 14	Ranger	6 440 C 5	200	82RS72	82RS72	1
Howard	PT-23	Continental	R 670 5	220	43K19181	90LA78	5
Piper	L4, A, B, H	Continental	A 65	65	43K10107	72C42	6
Piper	L4C	Lycoming	O 145 B 2	65	70LY34	70LY34	7
Piper	L4D	Franklin	4 AC 176 B 2	65	72F42	72F42	7
					72F44	72F42	
Piper	L4E, F	Continental	A 75	75	70D40	70D42, 70D44	6
					70D42	70D42, 70D44	
Piper	L4G	Lycoming	GO 145 C3	75	78LY52	78LY52	7
Ryan	PT-22	Kinner	R 56	160	90HASP90	90HA86, 90HA84	5
					90HASP90M	90HA86, 90HA84	5
					42K12335	90HA86, 90HA84	5
					42K12335M	90HA86, 90HA84	5
					43K26215	90HA86, 90HA84	5
						90H86, 90H84	3
						90HB86, 90HB84	4
St. Louis	PT-23	Continental	R 670 5	220	43K19181	90LA78	5
Stinson	L5	Lycoming	O 435 1	190	85LY58	85LY57	1
					43K23447	85LY57	1
					44K15005	85LYA57	2
					44K17191	85LY57	1
Stinson	L9A, B	Franklin	4 AC 199 E 3	90	72DF49	72DF48, 72DF49	7
Taylorcraft	L2A, B, H, M	Continental	A 65	65	43K10107	72C42, 72C44	6
Taylorcraft	L2D, F, J	Lycoming	O 145 B 2	65	70LY36	70LY36, 70LY38	7
					70LY38	70LY36, 70LY38	
Taylorcraft	L2E,K	Franklin	4 AC 176 B 2	65	72F42	72F42, 72F44	7
					72F44	72F42, 72F44	
Taylorcraft	L2G,L	Franklin	4 AC 150	50	70F45	70F45	7

NOTES

1. Warner hub 20 Spline 8 Bolts (8599, 8530, 7900)
2. Warner hub 20 Spline 6 Bolts (8808 or 43D24385)
3. Kinner 20 Spline Hub (1475 or 42K14179)
4. Kinner Taper Shaft Hub
5. AN Standard 20 Spline Hub (41G2325)
6. Continental Taper Shaft Hub (3475)
7. Integral Flange

Tear out and file for ready reference additional copies available upon request

SENSENICH BROTHERS, Lancaster, Pa.—adjacent to Lancaster Municipal Airport; West Coast Branch, Glendale, Calif.

AIRCRAFT PROPELLERS SENSENICH

A matter of inconvenience—nothing more!

OUR stranded friend is the victim of a faulty measuring device. The gauge said "quarter-full" when the tank was empty. The result—a little profanity and an hour's inconvenience.

But not all instruments can be excused so lightly. At work in this war, and in readiness for the years to follow, are thousands of instruments whose accuracy may mean the difference between success and failure, between safety and danger, between life and death. These instruments *must not lie!* Too much depends upon them.

Boes is building instruments of this character. To date, we have not been asked to create instruments in which an element of error could be tolerated. Quite on the contrary, we've been expected to produce instruments of greatest accuracy and, most important, instruments of *sustained accuracy.** The methods and facilities that are available for this work may be useful to you now, and will certainly be available to you in the years ahead.

• • • • • •

***SUSTAINED ACCURACY** is not an easy quality to achieve. It must take into account all factors of use—must then employ the design, the alloys, the construction that infallibly protect an instrument against all threats to its reliable performance. Such instruments, obviously, must be built with performance—not price—in mind. We invite the inquiries of those who are interested in such standards.

Boes instruments

for Measuring, Metering & Testing Equipment ☆ The W. W. Boes Co. Dayton, Ohio

placement of condensers at overhaul of gyro flux gate compass transmitter, and the use of matched orifice and inlet valve assembly in demand oxygen regulators. Tools and Fixtures is the classification of the final publication in the group. Superseding 37-20A, the booklet is numbered 46-21B and contains information of value in servicing driftmeters. *Eclipse-Pioneer Division, Bendix Aviation Corporation.*

Interchangeable Power Plants

Constellation Quick-Change. The "power egg" system which permits a complete change of engines for the C-69 Constellation in 27½ min. is described. It is reported that to achieve this interchangeability of power plants, particular attention was paid to the grouping of lines, ducts, and connections at the fire wall, with quick disconnections made for all units. Sequence and procedure of the change are given as follows: (1) carburetor air scoop removed to attach hoist, disconnections at fire wall started (3 min.); (2) disconnections completed, hoist sling secured, engine ready to be lowered (9 min.); (3) engine swung aside and lowered (11 min.); (4) new power plant swung into place preparatory to securing structural connections (15 min.); (5) engine in place, structural, electrical, hydraulic, and cable connections being made (23 min.); (6) new power plant completely installed, ready for propeller to be pulled through (27½ min.). *Lockheed Global Service Log,* Second Quarter, 1944.

Production and Maintenance Suggestions

The Hamilton Standard Blade, September 7, 1944. (1) A plate with various-size holes, used instead of micrometers for sorting screws and dowel pins, reduces the amount of time required for the operations; (2) grinding airplane propeller-blade segments to coarser measurements decreases the amount of rework.

The Curtiss Wright-er, September 1, 1944. (1) A jig to hold nose-assembly ribs while they are being burred before counterpressing; (2) a scriber for trim line on window frames; (3) a trim scriber for butt-joint skins; (4) a drill stop with a shoulder to prevent it from being jarred out of position.

Tulsa Douglas Airview News, September 8, 1944. (1) A drill jig enables 25 parts for the camera-door plate assembly to be put together in one operation instead of four; (2) a tool to form and solder a hydraulic-fluid strainer obviates manual work, reduces amount of time required for the operations, and eliminates rejections.

North American Skywriter, September 8, 1944. (1) Squeeze dies for longerons and motor mounts; (2) a jig for Erco rivets.

The B. F. Goodrich Circle-News, September 2, 1944. (1) Idea for reducing waste in buffing fuel-cell fittings; (2) method for improving the quality of fuel-cell fittings.

North American Aviation, Inc., Take-Off, September 8, 1944. A hinged type of blanking die can be set in a hand-squeeze gun for blanking cutouts and used in instances when it is not practical to make the cutouts in sheet-metal departments.

The Consolidated Vultee Volunteer, September 15, 1944. A drill adapter for burring permits parts to be burred faster and more efficiently.

Noorduyn Tale-Spin, September, 1944. (1) A new jacking device on the wing jigs locates the outer end of the wing while repairs are being made; (2) a drill jig for locating the holes in the trailing edges of wing flaps eliminates the use of marker and pencil for hole location; (3) a special jig for assembling several aircraft panels permits them to be installed as a single unit; (4) a fixture that can hold six parts for soldering eliminates the use of a vise and reduces possibilities of damage; (5) a gauge for holding stainless steel on a circular saw prevents the material from "jumping" during the cutting process.

North Ameri-Kansan, September 22, 1944. A combination fly-cutter tool and drill holder eliminates tool-changing operations on fixed gun supports.

The Arizona Goodyear Wingfoot Clan, September 8, 1944. (1) Standard method of routing cables by use of a "Z" frame, eliminates boggling throughout the bomb bay; (2) a wrench for locating nut plates; (3) a guide roller for spot welding; (4) a wire-winder that releases a coil after it is wound; (5) new type template for use in drilling on ring structure of Erco turrets.

The Consolidated Vultee Aircraft Corporation Convair News, September 15, 1944. A small hand-rolling machine is used in forming certain angles for the B-24.

Eastern Aircraftsman, September, 1944. (1) Holding the nut in place with a cleco pin while riveting it speeds up installation of anchor nuts on airplane assemblies; (2) a new type of clip for holding a plane's intercooler coupling sleeve eliminates welding operations in the fabrication of the clip.

The Fairchafters, September 8, 1944. (1) The use of Masonite in making a hydro-form die where the bend is short forces the rubber against the work and forms a groove by the edge of the work; (2) a Kirksite cast clamp die for swaging machine eliminates the use of expensive wood blocks; (3) removal of the subbase from a sander permits the sander to be used under the airplane in fitting bomb bay doors; (4) a jig for locating clips saves time and material; (5) the combination of a three-jaw universal chuck, a standard milling-machine vise base, and an adapter makes a tool that can take the place of a dividing head; (6) a metal template for the layout of the location of the rib and anchor nut bolt utilizes a rejected Duramold skin; (7) two straps joined with a turnbuckle draw the nacelle structure to desired position for the holes to be drilled in correct location on wobble-pump support; (8) the use of a wooden jig for bending ¼-in. aluminum and copper tubing results in a saving of time; (9) a bracket clamp sets the "time" on fuel clock control selector dials; (10) a drill, used for mounting holes on gear box, is ground in steps; (11) a jig locates the cutoff line in front of the tail cone and the spruce block inside for the tail light to be bolted on; (12) a jig is used to slip inside of the cone for reinforcement when the top of the cone is assembled; (13) a counterbore with six cutting edges used with a taper shank eliminates the use of a chuck in running off a drill press spindle.

North Ameri-Kansan, September 8, 1944. The use of flexible contact and safety wires in conjunction with redesigned circuit attachment plugs prevents breakage of line-conveyer shoes.

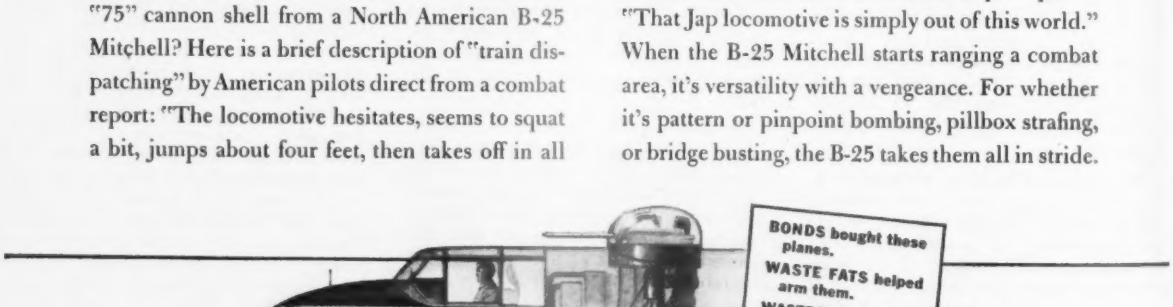
The Chance Vought News, September 7, 1944. Method of salvaging tube-sealing plugs.

Douglas Airview, September, 1944. (1) Assembly drill jig for rework of center section fuel-tank stiffener makes possible drilling of hat sections accurately in inaccessible places and also eliminates drill rework; (2) scribe trim bar for fitting and trimming cowling skins establishes proper tolerances and aids joining of contour skins; (3) combination tip for single-shot riveter accommodates various sizes and shapes of screw-rivet sets; (4) electronic test meter for calibration of maximum current relays on Sciaky resistance spot welders measures time interval consumed by spot-welding machine during actual physical weld and assures good weld; (5) development and installation of new lines using flare tubing to accommodate nut and sleeve of new line size insures line going straight into fitting; (6) tool for installing spare blocks in tie assembly without removing wings; (7) test unit adaptable to planes using C-1 autopilot stabilizer makes accurate ground check and eliminates the need for the highly sensitive installation previously used; (8) standard ridge reamer for wing bushing reworks sharp-edged bushing on plane without removal of wing; (9) fuel-gauge testing jig for testing gauges before installation calibrates exact depths of fuel tanks quickly and accurately; (10) tapered Erco punch for flush riveting of heavy skins enables punching heavier material more satisfactorily, eliminates 95 per cent of high-rivet heads, decreases swelling, and results in closer tolerances of contoured sections; (11) transfer-valve test equipment for automatic pilot gives positive check on plane's transfer valves under conditions equivalent to flight; (12) leaving tooling tabs on wing-panel skins after forming enables contours to be held to closer tolerances; (13) method of manufacturing cable lock by coining it from annealed steel instead of centrifugally casting it from beryllium copper proves

(*Continued on page 197*)

Train Dispatcher

WHAT HAPPENS when a Jap locomotive takes a "75" cannon shell from a North American B-25 Mitchell? Here is a brief description of "train dispatching" by American pilots direct from a combat report: "The locomotive hesitates, seems to squat a bit, jumps about four feet, then takes off in all directions at once." As one American pilot put it: "That Jap locomotive is simply out of this world." When the B-25 Mitchell starts ranging a combat area, it's versatility with a vengeance. For whether it's pattern or pinpoint bombing, pillbox strafing, or bridge busting, the B-25 takes them all in stride.


BONDS bought these planes.
WASTE FATS helped arm them.
WASTE PAPER helped ship them.
GASOLINE flies them.
WILL YOU help deliver the next squadron?

FLYING ARTILLERY—loaded by the navigator, fired by the pilot, this 75 mm cannon ads terrific fire power to the B-25 Mitchell.

North American Aviation *Sets the Pace*

PLANES THAT MAKE HEADLINES... *the P-51 Mustang fighter (A-36 fighter-bomber), B-25 and PBJ Mitchell bomber, AT-6 and SNJ Texan combat trainer, and the B-24 Liberator bomber North American Aviation, Inc. Member, Aircraft War Production Council, Inc.*

From the Industry

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Engineering Review.

Small Snap-Switch

Reported to be one of the smallest fully enclosed snap-action switches ever built, the new Miniac is only $^{17}/_{64}$ in. thick, $^{13}/_{16}$ in. high, and $1^{3}/_{16}$ in. long. It is designed on the rolling spring principle and is actuated by a stainless-steel pin plunger. All parts are noncorrosive and all contacts are of silver. Main blade, contact blade, and rolling spring are made of beryllium copper. The switch is rated at 15 amp., 115 volts a.c., and it is available in single pole, normally open and normally closed, double-throw type. It is designed to permit leaf-type or overtravel-plunger-type actuators to be attached to the case. Acro Electric Company, Cleveland.

Hydromatic-Propeller Test Stand

The PA 809 hydromatic-propeller test stand has been developed for testing all types of Hamilton Standard hydromatic propellers. Tests for feathering, internal and external leakage, checking distributor valve, and other tests can be carried out. Capacity and pressure are supplied by a heavy-duty 5-gal.-per-min. hydraulic pump driven by a 2-hp. motor. Pressure control is assured by use of a heavy-duty relief valve.

The filter system protects the pump and propeller being tested. A vacuum gauge instantly indicates restrictions or fouling lines. Two $4^{1}/_{2}$-in., 0–800 lb.-per.-sq.in. gauges give readings during tests. The operation is controlled by a set of four valves, and pressure is controlled by a fifth valve. The pump motor is a 2-hp., 1,200-r.p.m., 220-volt, three-phase, 60-cycle unit, controlled by a contactor with thermal overload protection. Motors of other voltages, phases, and cycles can be supplied.

The construction combines a welded steel frame with a sheet cabinet. Dimensions are: length, 48 in.; width, 28 in.; height 35 in. The approximate weight is 625 lbs. Airplane Manufacturing & Supply Corporation, Manufacturing Division, Glendale, Calif.

Refrigerator for Aircraft Use

For providing refrigeration in long-range transports and patrol airplanes carrying serums and vaccines, as well as certain foods, to distant theaters of war, a compact $4^{1}/_{4}$-cu.ft. refrigerator has been developed. It requires less than 3.5 sq.ft. of floor area and weighs 106 lbs.

All of the parts of the Airtemp radial compressor are made of aluminum to conserve weight except certain internal parts. It has superfinished moving parts and removable cylinder liners. The refrigerant used is Freon 12. The compressor is driven by a $^{1}/_{5}$-hp. electric motor of the special lightweight aircraft type, connected to the compressor shaft by V-belt. This shunt-wound motor operates at 1,725 r.p.m. on 24-volt direct current, but a dual voltage system is available which makes provision for the operation of the refrigerator not only on 24-volt direct current but also on 110-volt alternating current. The dual-voltage arrangement is provided so that when the plane is in the air the refrigerator operates from the plane's electrical system. On the ground it operates from commercial current when such current is available.

The cabinet is made of 22-gauge aluminum, reinforced with aluminum structural angles. It is finished inside and out with white Dulux enamel. An adequate vapor seal is provided and $3^{1}/_{2}$-in. insulation is used between all of the cabinet walls. The all-aluminum direct-expansion-type evaporator is equipped with two ice trays, freezing approximately 3 lbs. of ice at one time. An aluminum defrosting tray is provided with suitable clips for anchoring it in place below the evaporator. The two aluminum shelves have their front edges turned up to prevent containers from sliding off. The machine compartment is amply ventilated. The rear is open and the sides and front have open grilles. Four anchoring lugs, in addition to base-plate provision for deck bolting, provide means for securing the refrigerator in place.

The thermostat has an adjustable range to maintain cabinet temperatures of 35° to 50°F. An aircraft relay is installed in the thermostat circuit to carry the starting and running current of the motor. Other construction features include an automatic expansion valve of the adjustable type; back-seating type suction and discharge valves, fitted with seal caps; a four-blade aluminum condenser fan directly connected to the motor shaft; and a condenser coil of finned-tube construction made entirely of aluminum. Airtemp Division, Chrysler Corporation.

System for Control of Aircraft Landing

A solution to airway congestion intended to accommodate four times the present air traffic has been demonstrated at New York. When pilots use instruments instead of observing the ground, the system is expected to prevent many traffic delays. Normally, under instrument conditions it has been necessary at times to cancel and delay flights because of air-traffic congestion. In a demonstration of the functioning of the system in New York on August 29, five transport airplanes flying under simulated instrument conditions were directed to landings on a single runway in 16 min. and 40 sec. Using present-day procedures, more than 60 min. would have been required for the same operation. It is expected that the new system will direct transport airplanes to landings at a rate of 20 or better per hour under actual operating conditions. A feature of the development is the simplicity of operation and complete control over aircraft movements.

Positive altitude separation serves as the basic method of separating flights in the new plan. Flights awaiting their turn to land are held on 1,000-ft. altitude separations in the same manner as today, and no pilot is ever cleared to a lower altitude until the flight below has vacated such altitude. This separation is maintained without a break until the flight is actually on the ground.

Two radio markers, presently located $3^{1}/_{2}$ miles apart and used in conjunction with direction-finding equipment on the airplane, confine the holding pattern to a much smaller and more efficient area. The basic altitude separation is still maintained over the same wide lateral area that has proved reliable in years of operation with older methods. When some approaching plane is brought down to an altitude below 2,000 ft., an instrument developed by the inventor and the General Railway Signal Company is utilized to direct the plane from its position in the holding pattern and bring it over the outer marker on final approach at a predetermined time. This spacing of flights on the final approach path is accomplished by means of simple instructions to the pilot and is carried on

POLLAK
Pioneers a New Version of Re-conversion

Production for war has created new methods of co-ordinating the planning and development of products to supply future consumer demands.

To save valuable time for business leaders and their engineers in product design and manufacture, Pollak has developed a new version of reconversion.

Briefly, it is a pooling of the Pollak experience in modern design, new techniques in metals, and production short cuts, with the brains of the planning staffs of American industry.

This should result in increased economy and efficiency in production.

There is no obligation involved in this mutual planning. And it is successful. A number of mechanical parts and assemblies are already awaiting material and manpower releases to go into production at Pollak.

It is likely that Pollak facilities and capacity are large enough to absorb the manufacture of some of your products too. Please write, phone or wire us.

POLLAK
PRECISION
PRODUCTS

POLLAK MANUFACTURING COMPANY

Arlington, New Jersey

DEVELOPING • DESIGNING • MACHINE WORK • SPINNING • WELDING • STAMPING • ELECTRICAL WORK

without disturbing the basic altitude separation between flights.

The idea and the instrument were conceived by Samuel P. Saint while flying as a regular-line Captain for American Airlines. After discussing the principles of his proposed system with officials of American, Captain Saint was transferred to the Engineering Department where he has worked full time on the development of the system in coordination with flight-engineering personnel of the Army, Navy, and other air lines. The General Railway Signal Company has been instrumental in developing the overall system. The principles of the computer as used in the demonstration are to be incorporated in an automatic control system that will include interlocking and monitored control of altitudes. American Airlines, Inc.

Plastic Gasoline Tank for a Blimp

An auxiliary plastic gasoline tank that carries 100 gal. of extra gasoline for lighter-than-air craft is so light that a member of the crew can hoist it easily on his shoulder. It is reported to have adequate strength and a hard surface that is impervious to the effects of high-test aviation fuel. The tank is made for the U.S. Navy by use of Laminac, a new plastic material that is fabricated by impregnating sheets of cloth, Fiberglas, or other fabric with Laminac resin. American Cyanamid Company, Plastics Division, New York.

Aircraft Mooring Stake

An example of how new military needs can be met by a long-used civilian product is found in the new aircraft mooring stake produced from the standard drive-anchor post foundation developed by the manufacturer for its fences more than 50 years ago.

In this mooring stake a stub piece of $2^3/_8$-in. outside diameter pipe 30 in. long, with two shoes or clamps attached, is driven into the ground its full depth, leaving only the ring above ground. Then the earth surrounding the stub is removed to a depth of 4 in. This exposes the shoes. Two $1^1/_2$- by 30-in. angle anchor blades are inserted through the shoes at right angles to each other and driven into the ground flush with the top of the shoes, after which the earth around the top of the stub is replaced. These anchors spread out under the ground to form a "dead man" foundation approximately 40 in. across at the bottom. The tie downs are fastened to the ring, which lies flat on the ground when not in use. Anchor Post Fence Company, Baltimore.

Direct-Reading Magnetic Direction Indicator

A new direct-reading magnetic direction indicator compass, Type 2223, is particularly adapted to private aircraft and gliders. The azimuth pointer rotates in front of a fixed dial, making the compass easy to read. This instrument uses a standard $1^7/_8$-in. luminous dial, graduated every 5°, and

The Autoflight Corporation's direct-reading magnetic direction-indicator compass. The total weight of the instrument is 6 oz.

combines a short time of swing or period with a low value of overswing and a high lateral dynamic stability. The entire mechanism is permanently immersed in compass fluid. Wide-range temperature and magnetic compensation are provided within the housing, and each instrument is provided with a nonmagnetic adjusting screwdriver. The total weight is 6 oz., making it the smallest and lightest device of its kind according to the manufacturer. Autoflight Corporation, Burbank, Calif.

New Air Unit Converts Bench Vise to Automatic Machine

Vispeed, a new, powerful air- or hand-operated bench vise consists of a standard 4-in. Reed bench vise operated by an 8-in., foot-controlled air cylinder. Clamping pressures are adjustable from zero up to $2^1/_2$ tons, the practical safety limit of the vise itself.

The air unit operates through the full range of the 6-in. jaw opening of the vise. A positive safety control limits the air-powered movement of the movable jaws and is adjustable from zero to a maximum of 1 in. It is foot controlled, leaving both hands free to handle work. Slight toe pressure closes the jaws and heel pressure opens them. Jaws lock in either position. Normal hand operation of the vise is possible at all times.

The device is available as a complete packaged unit, consisting of a standard Reed bench vise, an air cylinder, pressure regulator, gauge, quick-exhaust valve, and air-hose and foot-pedal assembly, or the air unit may be purchased separately for easy attachment to any standard 4- or $4^1/_2$-in. vise. The Bellows Company, Akron, Ohio.

Telephone-Type Relays

Betts and Betts Type RAC midget-type relays are especially designed for communication, electronics, and aircraft applications. They are reported to meet Army Air Forces tests for altitude, vibration, shock, humidity, and extreme temperatures.

Coils are protected against moisture, corrosion, and electrolytic action and have a voltage range from $1^1/_2$ to 70 volts d.c. The magnetic circuit permits operation with 25 per cent voltage fluctuation. Insulation is inorganic-base plastic. Every unit is subjected to a 1,000-volt breakdown test.

Any arrangement of contacts can be supplied for making, breaking, or both, up to twelve contacts. Contact springs are of alloy with overall welded silver contact surfaces. Sufficient back pressure assures dead-beat positive wiping action. Contact capacity is 2 amp. at 100 watts. Dimensions are $1^7/_{16}$ in. long, 1 in. wide, and $1^1/_{16}$ in. high, including the first two pairs of contacts. Each additional two pairs of contacts add $^1/_8$ in. Weight is $1^1/_4$ oz. Betts & Betts Corporation, New York.

Aerodynamic Braking

Aerodynamic braking by reverse thrust is accomplished by changing the angles of the propeller blades to negative "pitch," thereby creating a backward thrust. In tests with four-engined airplanes, conducted by the Army Air Forces Air Technical Service Command, the application of reverse thrust from two propellers, but without mechanical brakes, was found to be equally as effective as normal application of the wheel brakes.

The use of two or four propellers reversed, in combination with brakes, results in a great reduction in the landing run. Tests have demonstrated also that the deceleration of multiengined planes with reverse thrust is exceptionally smooth, providing greater comfort to passengers. Engineers forecast that it will be found possible materially to reduce the size and weight of wheel brakes on aircraft equipped with reversible propellers. This weight-saving will be reflected in an increased airplane pay load.

With the adoption of reverse-thrust braking, the landing run becomes shorter than the distance required for take-off with current aircraft, making the take-off distances the prime basis on which airport lengths in the future will be determined, according to the engineers' forecast.

Because reverse-thrust propellers are most effective at higher landing speeds, the new propeller-braking application is considered an important development for the larger transport airplanes of the future, with their anticipated higher landing speeds. Curtiss-Wright Corporation, Propeller Division.

Seam-Coating Compound

A synthetic-resin, heavy-bodied, durable oil-base compound for coating seams of riveted gasoline tanks and filling joints in pontoons or floats is being marketed to the aviation industry as No. 1625 Water and Gas Resisting Dolfinite.

Remaining flexible and tacky, it allows completion of riveting operations that may consume several days. It

The Lockheed Constellation

Highest cruising speed of any transport
Longest range of any transport
Greatest load-carrying ability of any transport
Highest rate of climb of any transport
And these performances
make the Constellation the *safest* of any transport

SETS NEW WORLD STANDARDS IN AIR TRANSPORTATION

Air transportation has reached a remarkable degree of efficiency since the Wright brothers first flew 41 years ago—progress which has reached a new peak in Lockheed's Constellation. Town connector, continent spanner and empire blazer, it not only shrinks space and time, but brings new safety, comfort and economy to air travel for short as well as long distances.

Lockheed Aircraft Corporation, Burbank, California

resists vibration and gas and water pressure, is not affected by change in atmospheric temperatures, and eliminates the use of tape.

The compound can be extruded mechanically with a pressure gun or applied with a glazing or putty knife. It will not ooze or run, is noncorrosive, and is reported to have no deteriorating effect on aluminum, aluminum alloy, stainless steel, or any other alloy metal. A ribbon of this material is applied before riveting. The manufacturer states that when the assembly is completed a tight seal is effected. The Dolphin Paint and Varnish Company, Toledo, Ohio.

Making Bubble Canopies

The process for producing plastic bubble canopies by atmospheric pressure to form clear enclosures from single sheets of Lucite methyl methacrylate resin for P-51 Mustang fighter planes is now in full-scale production.

The enclosures are drawn in a vacuum die, eliminating contact of molding dies with the plastic, preserving its optical properties. The new method not only eliminates distortion, which is a handicap to accurate gun sighting, but also speeds up production rates.

At Swedlow Aeroplastics Corporation, Glendale, Calif., where the enclosures are produced, sheets of the plastic material are first trimmed to the general outlines of the canopies. The cut sheets, which are approximately oval, are then placed in ovens and heated to the point where the thermoplastic becomes flexible. The limp sheets are next draped upon the vacuum device and clamped at the edges to form an airtight die. Air is exhausted from the die by pumps and the plastic is expanded by the pressure of the atmosphere to the specified contour of the enclosure. The operator is guided by a gauge that indicates the progress of the forming operation.

Upon cooling, the Lucite hardens and is removed from the die. It is then machined and fitted into the structural metal stripping by which it is attached to the plane. E. I. du Pont de Nemours & Company (Inc.).

Gyroscopic Gun-Sight Computer

A new gyro "lead computing" gun sight brain, which Bendix Aviation Corporation and the Eastman Kodak Company jointly adapted for quantity production, is an American version of the British "Mark II-D" device. It is reported to combine the most efficient qualities of previous reflector and computer gun-sight types that have been under constant development by both the Army and Navy for several years.

Navy gunners using the gyro sight are required to make only two manual adjustments in attacking enemy aircraft. First they turn a lever to indicate the type or size of enemy plane to be attacked. Then they turn a twist grip to indicate the range of the enemy plane.

Numerous electrical units, including a small gyroscope and a small d.c. motor, then go into action to compute automatically all necessary deflection information required to register hits on enemy aircraft.

The new gun-sight device not only computes automatically the distance an enemy plane must be "led" to score a hit but also keeps before the pilot or gunner a constantly accurate image of the target, even in the rapid maneuvers of aerial combat. The gunner's visual aiming ring or reticle can be increased or decreased manually according to the size of the target image.

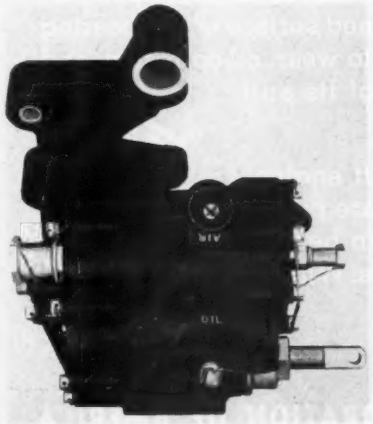
To adapt the British device to American volume manufacturing, the corporation also made its own production drawings and developed new and faster methods of forming many of the parts of the gun sight. Eclipse-Pioneer Division, Bendix Aviation Corporation.

Supercharger Regulators

Eclipse Type 581 Supercharger Regulators, designated as Model 12 for updraft carburetors and Model 13 for downdraft carburetors, are designed to operate independently of the carburetor throttle, automatically controlling the auxiliary stage of a two-stage engine supercharger system to produce constant carburetor air inlet pressure. Control of the water-injection system for emergency power also is incorporated in these models.

The carburetor inlet air pressure in a typical application is automatically held constant, at any altitude within the rated limits of the engine, by throttling the inlet to the auxiliary stage. The sensitive element measures the carburetor inlet air pressure and functions continuously to prevent that pressure from dropping or exceeding the setting. The auxiliary stage inlet throttling valve is adjusted by an oil-actuated servo piston, regulated by a valve connected to the sensitive element.

The emergency-power water-injection system is controlled by a bellows that resets the supercharger regulator, during water injection, to a higher value.



The Eclipse Type 581 supercharger regulator weighs 4.75 lbs. and provides automatic control of auxiliary stage superchargers maintaining constant carburetor inlet pressure.

The regulator is automatically reset to normal when the supply of water is exhausted or when water injection is discontinued.

The bellows provides a constant pressure control regardless of atmospheric pressure or temperature variations, and the lightweight bellows assembly reduces acceleration loads. A balanced oil-control valve provides accurate regulation regardless of oil-pressure variations.

Internal oil-pressure and oil-drain passages contribute to the ease of installation and tend to make the unit less vulnerable to danger. The bellows assembly is submerged in oil, preventing damage from vibration and lubricating all operating mechanisms.

Mounted on the accessory drive section, the regulators are compact and light in weight, weighing only 4.75 lbs. Dimensions are $7^{13}/_{16}$ in. wide by $5^{3}/_{8}$ in. deep by $6^{19}/_{32}$ in. high. Eclipse-Pioneer Division, Bendix Aviation Corporation.

Internally Cooled Electrodes for Spark Plugs

Longer service life for aircraft spark plugs was the motive for the development of an internally cooled center electrode. The new electrode is composed of a drawn nickel-alloy cap into which is fitted and brazed a copper core, thereby affording greater internal cooling by increased thermal conductivity and reduced erosion of that member.

It was made possible by a method for drawing the sleeve from strip stock. The drawn nickel cap can be held to close limits and has the additional advantage of being work-hardened. The work hardening and the internal cooling of this electrode in combination with a noninductive resistor are reported to have increased the electrode life of this spark plug by 300 per cent. The Electric Auto-Lite Company, Toledo, Ohio.

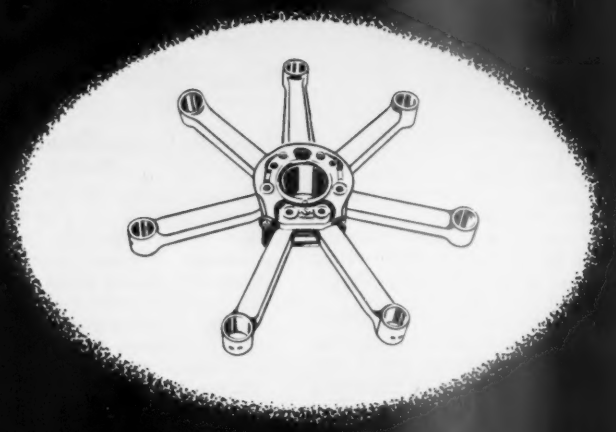
Method of Tipping Cutting Tools

Two outstanding silver-copper and one copper alloy are now available in the form of a fine powder to be used for tipping tungsten-carbide and high-speed steel tools. These alloys are economical in use since the required flux is mixed with the powdered alloy, which eliminates any waste of flux during preparation.

These alloys are known as EutecRod No. 1800 (lowest melting) for high-speed steel, 940°–1,140°F.; No. 1601 (high tensile) for tungsten carbide, 1,020°–1,250°F.; and No. 16 (heat resistent, high tensile) for tungsten carbide, 1,300°–1,750°F. (furnace temperature).

After the customary degreasing and grinding, the powdered alloy is spread on the surfaces to be joined, and the tungsten-carbide tip is placed on top. The assembly is then heated until the alloy melts. The metal flows freely at a slight increase in temperature above the melting point, since the weld metal is pulverized. Oxidation of the tungsten carbide is prevented, since each particle of molten alloy immediately "tins" and

BETTER BEARINGS *with* INDIUM



New records for motor bearings life—several times pre-war's best—are being turned up despite the tight situation in white metals. In INDIUM, manufacturers found the answer.

By plating INDIUM onto the contact surface of the bearing and then diffusing it, metallurgists are able to impart a high concentration of INDIUM just where needed. The hardened surface of the bearing proved far more resistant to wear, oil-corrosion, and softening, without loss of its anti-friction value.

Several builders of aircraft engines, Diesels, and motor trucks are putting this life-giving element in bearing metals for their power units. Why not see what it can do for you?

ARMY E NAVY

INDIUM CORPORATION OF AMERICA

Pioneers 40

THE INDIUM CORPORATION OF AMERICA

UTICA, N. Y.

New York Office: 60 East 42nd Street, New York 17, N. Y.

adheres to the surfaces being joined. Eutectic Welding Alloys Company, New York.

Survey of Air-Freight Possibilities

A survey conducted by the U.S. Department of Agriculture and the Edward S. Evans Transportation Research finds that moving perishable cargoes by air freight under contract-carrier operation, inherent to this type and size of operation, will make possible shipments of agricultural commodities from the West Coast producing areas to Eastern consuming centers at less than 6.55 cents per ton-mile. On the return haul manufactured goods can be flown from Detroit to San Francisco.

This concept of an all-cargo air-line operation on a contract-carrier basis is reported to permit relatively lower operating costs per mile and greater flexibility to follow the seasonal shifts of growing areas. The idea of contract-carrier operation, suggested by the research, is now being studied by other Government agencies.

The study demonstrates that a bulky, low-value, perishable commodity, such as lettuce, can be successfully marketed, even at a slightly higher price, reflecting the additional cost of air transportation, thus opening a new field for air-transportation of a substantial tonnage of agricultural commodities. Lettuce alone accounted for 6.8 per cent of all carload shipments of fresh fruits and vegetables in 1943, and in dollar volume amounted to $79,696,000.

This comprehensive report titled "Postwar Air Transport Costs and Markets for Lettuce" was jointly prepared by the Bureau of Agricultural Economics of the Department of Agriculture and the Edward S. Evans Transportation Research.

The first section of the study, a postwar cost analysis, is the work of the Aviation Division of the U.S. Department of State, assisted by the Director of Research for the United Fresh Fruit and Vegetable Association.

The marketing section of the report was prepared by the Bureau of Agricultural Economics of the U.S. Department of Agriculture. Also cooperating were the Grower-Shipper Vegetable Association of Salinas, Calif., and the Bureau of Plant Industry of the Department of Agriculture. The report was printed as a public service by Rand McNally & Company.

It was shown that lettuce can be flown from the Salinas-Watsonville growing area in California, the largest single producing area of lettuce in the country, to the consuming markets in Detroit and other nearby cities such as Chicago, Cleveland, Milwaukee, Pittsburgh, and Toledo, for approximately 3¾ cents per lb. net more than the surface-transported lettuce. Four test shipments were made via Air Express over T.W.A., and the air-borne lettuce sold readily, though priced at retail 5 cents per head higher, in the four Kroger retail stores in Detroit where the market was explored.

the Martin Mars means *Payload!*

World's greatest airmail load, these 25,000 pounds of mail were carried from Hawaii to California by the mighty Martin Mars a total of 62,500,000 pound miles for a single non-stop flight. At an average of ½ ounce per letter, that's 800,000 letters . . . and if they were all paid for at prevailing rates, they would carry $160,000 in postage.

This load not only smashed all previous records for airmail, but more than doubled the 23,750,800 pound miles traveled with the all-time cargo record of 35,000 pounds which the Mars carried from Belem, Brazil to Trinidad on its first war mission for the Naval Air Transport Service.

Thus in payload, as in economy of operation, the Mars far outstrips all rivals. And her 20 sisterships, now being built by Martin, will offer even greater payload, lower ton-mile costs, and higher speed. Best of all, war's end will find Martin production lines fully tooled and manned by experienced workers to assure early delivery of commercial versions of the Mars. It's no wonder the Martin Mars is known as "the answer to an airline's prayer!"

THE GLENN L. MARTIN COMPANY
BALTIMORE 3, MARYLAND, U.S.A.
The Glenn L. Martin-Nebraska Company—Omaha

Martin AIRCRAFT

Builders of Dependable Aircraft Since 1909

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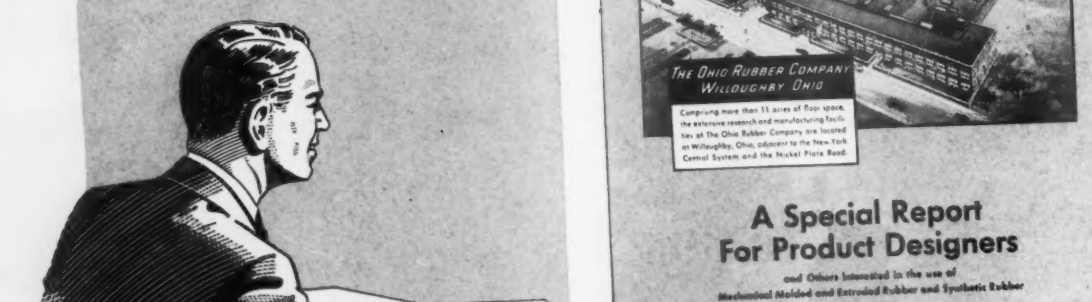
ORCO
MECHANICAL MOLDED AND EXTRUDED RUBBER PRODUCTS
THE OHIO RUBBER COMPANY
WILLOUGHBY OHIO
Comprising more than 11 acres of floor space, the extensive research and manufacturing facilities at The Ohio Rubber Company are located at Willoughby, Ohio, adjacent to the New York Central System and the Nickel Plate Road.
A Special Report
For Product Designers
and Others Interested in the use of
Mechanical Molded and Extruded Rubber and Synthetic Rubber
OHIO
BRANCHES: DETROIT · NEW YORK · CHICAGO · INDIANAPOLIS · WASHINGTON · CLEVELAND

if you face Problems in Rubber

Condensed and to the point, this 8½x11, 4-page report contains a wide scope of information on mechanical molded and extruded rubber and synthetic rubber, including data on the comparative bonding qualities of those materials in relation to various metals, wood, fibre, celotex, and glass. Although this report was compiled primarily for product designers, anyone interested in the uses and applications of rubber and synthetic rubber may find helpful information. A copy will be sent to you upon request to * * The Ohio Rubber Company, Willoughby, Ohio. * *

"ORCO-OPERATION"

THE OHIO RUBBER COMPANY · WILLOUGHBY, OHIO

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Savings made possible by air transport, as stated in the report, are: packing without ice, lower handling costs, less bruising in transit and consequent waste, and greater yield per acre since fewer lettuce leaves need to be removed from each head. Also, the vitamin content is found to be greater when time in transit from field to store can be cut from 8 days to approximately 24 hours. The lettuce lasts longer and remains more attractive while on display in the store.

Lowered costs are likely after the war, according to the report, by using (1) lighter and more efficient shipping containers; (2) new nonstop airways between distant cities; (3) airplanes designed specifically for hauling commercial cargoes. Quoting the report: "In the aerial freighter of the future, speed may well be sacrificed to economy and the design of cargo compartments, among other engineering accomplishments, will most certainly be more efficient than in present-day transport aircraft."

Operating cost figures in the air transport section were based on the regular operation of a contract-carrier air line using eight Douglas C-54A Skymaster cargo planes. Capacity loads of lettuce and other perishables were planned for each West-to-East trip, and three-quarter capacity freight loads of manufactured goods for the return hauls. Figures on the operating schedule, routes, approximate cost, and probable shippers are outlined in detail in the report. All estimated cost data apply with only minor adjustments to cities within approximately 300 miles of Detroit. Edward S. Evans Transportation Research, Washington, D.C.

Peening Square Rivets Automatically

An automatic method of peening square rivets into small steel cams in less than 2 min. has been devised to replace a hand method that required 25 min.

In riveting a cam to the shaft of an aerial-camera camshaft, the surface was obstructed by other parts, limiting the peening clearance to less than the width of a square rivet. Since the camshaft is the heart of the between-the-lens type camera shutter, opening and closing its leaves at $^1/_{800}$ of a second, great care is given to its precision machining. Until recently, skilled employees were required to use special tools in hand-riveting the camshafts.

The problem was solved by removing the pulley on the riveting hammer and fastening a horizontal shaft to hold it in place. The hammer cannot swing or turn but, instead, has the desired up-and-down motion. This eliminates the serious hindrance of the hammer's rotation and enables it to be utilized for peening square rivets on extremely small surfaces. Allied with this, a special fixture was designed for holding the varying types of parts to be riveted.

This holding fixture is made of two sections, a base and an adapter. The base is standard for all jobs, whereas individual adapters can be provided for separate jobs. The base is screwed onto the table of the riveting machine. A center sliding part, controlled by the handle, moves forward and back, adjusting the position of the part to be riveted so that it conforms to the width of the square rivet. The interchangeable adapter or top part of the fixture can be revolved 90° and has a spring clamp to hold the part down during the riveting process. The riveting hammer itself conforms to the desired shape of the square rivet. When one side of the riveting operation is accomplished, the fixture can be lifted and turned 90° for the second and concluding operation. Fairchild Camera & Instrument Corporation.

Special Cam-Cutting Machine

Details have been announced of a special cam-cutting machine which completes in 15 min. a job that formerly consumed 80 hours of highly skilled labor. Designed to cut two irregular curved tracks of minute dimensions on the inside of a small metal barrel, the machine has proved highly successful in operation, increasing the production rate of war instruments that utilize the barrel cam.

One of the most important of these instruments is the Fairchild electric gun sight for aircraft. The barrel cam, $1^3/_8$ in. in diameter and 3 in. long, plays an essential part in focusing the gun sight's lenses on enemy targets. This pair of lenses is moved by means of a small metal shoe which catches in the cam's tracks. Unless these 0.062- by 0.072-in. tracks are perfect, clear focusing on the target is impossible. The designer undertook to provide a machine that would cut 5,000 barrel cams in the least possible time, a job that would ordinarily have to be done manually, consuming 400,000 man-hours. With the resulting cutter, the job was done in 1,250 hours.

Assisted by a tool designer in the plant, the inventor planned an assembly including a carriage, chuck, and two master cams in one unit, stationary followers in the second, and a third cutter-head unit. The most difficult parts to design were the two master cams. These govern the track cutting, giving it a forward motion. In one revolution of the master cam the barrel turns three times, and a track is milled on its smooth surface. This revolving action is attained by one worm and two worm gears. Weights keep the master cams in constant contact with stationary followers.

In designing the cutter head, special care was needed to make it small enough to fit inside the barrel cam. Revolving 5,000 times per min., it is driven by an electric motor by means of a round belt. Mounted on ball bearings, the carriage is so sensitive that through its handle the cutter's slightest dullness or smallest break can be easily detected by the operator. Holding the cam and chuck, the carriage applies the forward motion supplied through the master cam.

To produce the machine as quickly as possible it was constructed by welding all parts except the base, which was made of cast iron. The machine stands 1 ft. high, with a base about 3 ft. long and 1 ft. wide.

Though the machine was originally designed to fulfill the need for a particular type of barrel cam, it is equally adaptable to the manufacture of other types. The device is expected to be applicable to any optical instrument using the barrel-cam principle, such as telescopes and binoculars. Fairchild Camera & Instrument Corporation.

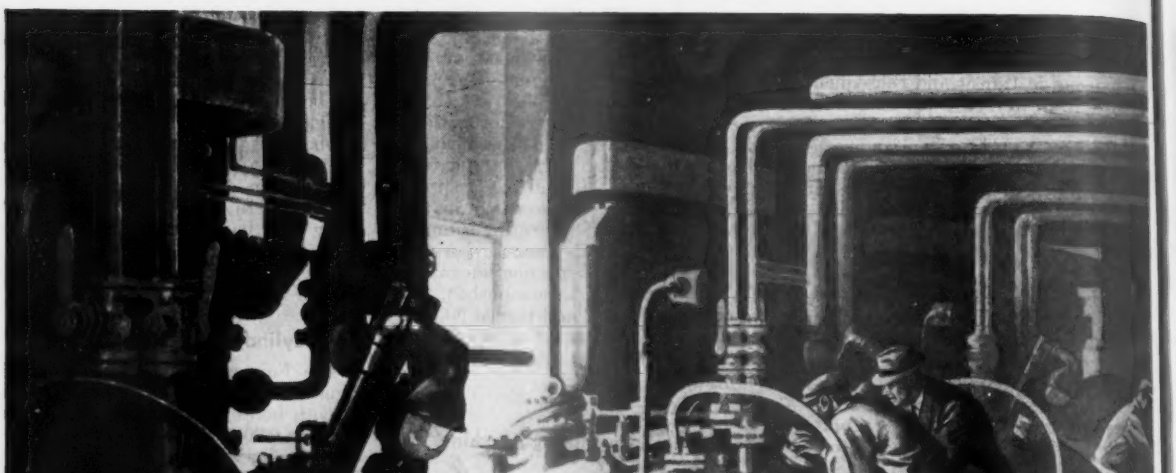
Cylinder-Honing Machine

The Fulmer honing machine is designed to produce straight, round, smooth bores to working tolerances as small as 0.0002 in. for finishing aircraft-engine cylinders, connecting rods, other internal-combustion cylinders, supercharger parts, landing-gear struts, recoil cylinders, and the like, where superfine cylinder surfaces and extreme accuracy are required. It can be supplied in various working stroke lengths up to 72 in., and with cylinder-honing capacities up to 20 in. in inside diameter.

All the controls have been brought down to "floor level" by the use of a patented control system, and they are located at the front of the machine within easy reach of the operator. Stroke-setting, hone withdrawal, "short stroking," changes in spindle or reciprocating speeds can be handled instantly from the floor or operator's station. Spindle and shafts are heat-treated and mounted on oversize roller or ball bearings, all operating in a bath of oil, adequately protected from dust and grit. Coolant is carried in the base of the machine and passes through multiple settling chambers before being repumped to the work. The pump system permits cleaning the solid matter in the coolant system quickly, without loss of coolant or productive time.

With the patented "stop and dwell system," the reciprocating spindle can be hydraulically stopped at any point within the stroke capacity of the machine without shock or impact to the machine or work. The spindle is "locked in" at such stopping point and can be held there before upward movement, in definite increments of seconds that are electrically timed. This timing ranges from 1 to 30 sec. and the time is not affected by variations in oil temperature or viscosity, as would be the case with timing controlled by the hydraulic oil passing through an orifice of various sizes.

When reciprocation is stopped, there is no pressure in the hydraulic pump line and the reciprocating mass is hydraulically sustained at that point in the stroke range. There is no "overrun" of the spindle at top or bottom of the stroke at whatever reciprocating speed for which the machine may be set. This facilitates honing blind-end cylinders or up to an internal shoulder. The controls can always be re-set to obtain the same result, when a change-over of work is desired.



Stainless Steel Lined Polymerization Reactors in Synthetic Rubber Plant

Equipment of Stainless Steel, Nickel and Monel meets many specialized requirements

Chemical engineers have met America's wartime challenge.

They opened the gates to a mighty flood of products going to war... strategic raw materials, synthetic substitutes, and entirely new substances having advantages all their own.

A factor in this production success is the wide use of stainless steel, Monel, and other corrosion-resistant alloys containing Nickel.

For in the chemical industry corrosion is a large-scale menace.

To wage war on this enemy, chemical engineers enlisted the aid of Nickel, because Nickel imparts to other metals strength and resistance to corrosion and wear. In the chemical field, as in many others, a little Nickel goes a long way to keep equipment producing.

It prolongs the life of processing apparatus, and protects the purity, color, and uniformity of the product.

Hence, stainless and Nickel alloys are specified widely for acid heaters and caustic coolers, for high-pressure autoclaves and vacuum evaporators, for cracking towers and polymerization reactors, for shipping drums and tank cars, for pumps, piping and storage tanks, for agitators and settlers, for stills and digestors—for every type of equipment that converts laboratory experiments into full-scale chemical operations.

For years we have enjoyed the privilege of cooperating with technical men of the chemical industry... and of many others. Whatever your industry may be ... if you want help in the selection, fabrication, and heat treatment of alloys ... we offer you counsel and data.

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★ Nickel ★

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall St., New York 5, N. Y.

For maintenance and service work on aircraft-engine cylinder barrels, the machine is equipped with a universal cylinder-barrel holding fixture. Adaptor plates and hone-guide bushings can be obtained to hold any size barrel specified. C. Allen Fulmer Company, Cincinnati.

Air-Operated Piston-Ring Lapper

By using the Fulmer piston-ring lapper, it is reported that many hours of "run-in" time of a new or overhauled engine can be saved. From ten to 25 strokes of the machine are all that is normally required to lap a conventional set of rings. Proper fit, enabling the engine to be run at full power, is obtained in minutes instead of hours. The machine will lap full sets of rings into cylinder barrels up to a maximum bore of $6^3/_8$ in. On special order, machines can be supplied to lap rings for bores greater than $6^3/_8$ in.

The lapper has been designed to give a half revolution of the spindle on a full outstroke, with no rotation on the return stroke. At each reciprocating cycle the spindle "hunts" so that there is no possibility of the abrasive traveling over the same path during the next stroke of the lapping operation. The spindle operates in a bath of oil and carries a wiper seal to protect it against dirt and grit. Stroke setting stops can be set to give working strokes from 2 to 12 in. and a re-set counter tells the operator the number of strokes for each operation.

The air-operated machines are built for operation with air under pressures up to 100 lbs. per sq.in. A hydraulically operated model also is available.

Adaptor plates can be supplied to hold any size cylinder required, and the cylinders are locked in position with quick-action clamps. Steel lapping heads that do not require the rings to be opened in putting them on or taking them off can also be supplied for any engine. C. Allen Fulmer Co., Cincinnati.

Single-Phase Autotransformers for Aircraft

General-purpose single-phase autotransformers are designed especially for operation from line-to-neutral of 400-cycle, 120/208 Y-volt, aircraft electrical systems. They are particularly adaptable for operation of 28-volt lamps, electrically heated flying suits, and other low-voltage aircraft accessories.

The small size and light weight of these autotransformers are made possible by the combination of a new high-grade core steel and glass insulation impregnated with a new high-quality, inorganic resin.

Suitable for operation at any altitude from sea level to 60,000 ft., they are intended to function properly in temperatures from −40° to 140°F. They are satisfactory for operation over a frequency range from 380 to 420 cycles and are suitable for continuous use at an overvoltage of 5 per cent. General Electric Company.

Stud Removing Simplified

A self-locking jam nut is used to remove studs without damaging the threads.

Two standard nuts—one slotted lengthwise—are backed against each other. The pressure of a wrench on the split nut binds it to the stud threads, providing extra friction by which the stud may be removed. The second nut is used as an anchor. General Electric Company.

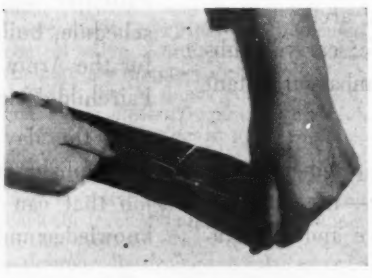
Pressure-Tight Zippers

The Pressure Sealing Zipper is a new development in unique rubber construction applied to metal slide fasteners to make them waterproof and prevent excape of air or gases.

The construction incorporates overlapping rubber lips, which have initial pressures built into them so that they assure a tight seal against any pressure that the structural strength of the slide fastener will withstand. The lips are placed on either side of the article to be sealed, depending on where the pressure is exerted. Used on the outside they make the article waterproof and prevent the entrance of air or gases. Used on the inside they prevent the escape of air, gases, or liquids held in the vessel.

Three styles are being manufactured, two being of the nonseparating type—the first, sealing along its entire length but open at the top; the second, sealing along its entire length and at both ends. In the first, which is used in such applications as for resisting exposure to water, gas, or other elements, the slider is operated from either or both sides; in the second, originally developed as a closure for pressure vessels, it is operated from the side opposite the sealing lips. The third construction is of the separating type, which seals for the entire length but not at the ends, with the slider operating from either or both sides.

The new zipper can be applied to metal, fabric, or sheet rubber, provided sufficient clearance is allowed for operation of the fastener. Installation can be accomplished either by stitching or cementing, depending on the application. The pressure seals are effective in a wide temperature range, not cracking when bent at −70°F. nor becoming soft at 150°F. Weathering and aging characteristics are reported to be excellent. One of the great advantages of the sealing-lip construction is that it conforms to changes in position of the sealing wall, withstanding stresses caused by these movements.



A new development, a pressure-sealing zipper manufactured by The B. F. Goodrich Company, prevents the entrance or escape of air or gases, depending on the application of the zipper.

Among the wartime uses for the zipper, according to the maker, are as closures for lifesaving suits or divers' suits, which need to be waterproof. Use of the zipper makes these much easier to put on or take off. Many uses of the new development are expected in the aircraft industry, including application on both high- and low-pressure ducts, where sections may be effectively joined with a pressure-sealing zipper on doorways and handholes, where there are pressure differentials, and on bail-out kits and instrument cases.

Tests on suits equipped with the zippers have shown them to be waterproof when immersed for long periods and to hold water, air, or gases without any perceptible escape. The B. F. Goodrich Company.

Motion Picture Portrays Tracer Control

"An Exact Duplicate" is a new 30-min. motion picture in colors and sound, showing many new techniques in Tracer-Controlled milling, engraving, etching, and duplicating. This motion picture is intended to provide its audiences with short-cut solutions to post-war production problems. It gives production men an opportunity to see Tracer Control at work on actual jobs and to hear simultaneously a description of the work as it progresses. Many of the applications of Tracer-Controlled machines shown are similar to jobs now being run in machine shops and on production lines all over the country.

The picture was filmed under the supervision of the same engineers who developed the Tracer-Controlled machines, and all the jobs shown in the picture were photographed in a machine shop. Close-up photography shows all features of work, master and machine. The spoken commentary clearly describes each operation and enables even those not familiar with the operation of Tracer-Controlled machines to understand their efficient, timesaving applications to these jobs.

The film is available without charge for showing at meetings of technical societies, company groups, etc. All expenses of the showing are borne by the manufacturer of the machines. George Gorton Machine Company, Racine, Wis.

Metal-Ceramic Electric Heating Unit

A new flexible, "serpentine" electric heat unit can be coiled in small or large turns around pipes and cylinders, spiraled around molds, or fitted to odd contours. The unit is of metal-ceramic construction and can be made in varying lengths and diameters and in capacities up to 15 to 20 watts per lineal inch. Exact temperatures up to 1,000°F. can be maintained without deterioration of the steel-ceramic structure.

WINGED FOR VICTORY *by Fairchild*

On wings built by Fairchild, the Navy's big patrol bombers—Martin PBM-3 Mariners—fly to war over the seven seas.

They've sent many a submarine to the bottom. They soar by the hundred over icy arctic waters; patrol the far reaches of the Pacific; carry bombs and munitions, cargo and men to combat on distant naval fronts.

Behind their constantly increasing numbers is the story of industrial America at war—the story of American vision, enterprise, initiative and cooperation combining to accomplish the "impossible".

Three years ago there was a critical need for these big flying boats. Fairchild undertook the job of building the vital wing panels despite the fact that Fairchild had just launched a heavy production schedule, building famous Cornell primary trainers for the Army Air Forces, and manufacturing other Fairchild-designed aircraft.

In this day of industrial miracles, this Fairchild accomplishment stands as another example of the job that can be done with cooperation, technical knowledge and production skill.

BUY U. S. WAR BONDS AND STAMPS

Fairchild Aircraft

Division of Fairchild Engine & Airplane Corporation, Hagerstown, Maryland....Burlington, North Carolina

Heat may be applied through direct contact of the unit or may be transferred through clips or fixtures of various designs. The unit may be left exposed or may be sealed or coated with insulating cement.

Applications have been designed for deicing installations on airplane-engine nacelles and on hangar doors, also on molds where critical temperatures must be maintained, and on melting pots of unusual shapes. Other applications include the heating of pipes and valves carrying viscous fluids. Experimental work is being done on various applications in the plastic field. H. & A. Manufacturing Company, Buffalo, N.Y.

Film about Welding

New Horizons in Welding is the title of a 16-mm. educational talking motion-picture film that gives a 30-min. presentation. It deals primarily with the setup for production welding, picturing the step-by-step procedure followed where welding is used on a high-speed, quantity-production basis. It is intended to educate in the methods used to reduce costs and speed production in modern fabrication of metal products. The picture traces the rise of welding from a mere implement of repair to a major production tool.

The film is available for use by manufacturers, trade schools, Government departments, and other groups interested in instruction in welding. Harnischfeger Corporation, Welding Division, Milwaukee.

Heat-Treat Oven for Use in Welding Shop

A small oven has been designed for preheating inner and outer cylinders of certain airplane parts to a temperature of 800° to 900°F. before welding. It eliminates the use of the large ovens in the heat-treating department, as it is operated right in the welding department where it heats the parts quickly and evenly so that the production welder does not have to wait for delivery of the heated parts.

Fabricated by welding of 1/4-in. steel, the oven is composed of a double wall lined with 1-in. asbestos sheeting all the way around. The box has a removable lid on which a fixture is welded so that an air-pressure gas cap shoots a flame into the oven, hitting a square of fire brick. The oven, measuring 24 by 24 by 18 in., is mounted on 1-in. pipe legs and is heated by city gas. It has proved satisfactory for quick preheating, blueing two cylinders in 10 min. In this case four different parts are welded to form the one aircraft assembly. The material that is preheated and welded is chrome-alloy steel. The Hobart Brothers Company, Troy, Ohio.

Kaiser Interests to Develop Hiller-copter

Under the terms of a recent agreement the research and development work on the Hiller-copter will proceed under Kaiser Cargo, Inc. That company has acquired the patents by purchase and has entered into an employment contract with Stanley Hiller, Jr., under which he will design and build helicopters for the Kaiser organization. The work will be done at a factory in Berkeley, Calif.

The machine is reported to be so simple to operate that both Mr. Kaiser and Clay Bedford, Manager of the Kaiser organization's Richmond Shipyards, took the controls and actually flew the helicopter alone with less than 5 min. of instruction. In commenting on the flights, the test pilot said that he believed this machine has excellent controllability and that the vibrations throughout the entire machine are relatively small. Kaiser Cargo, Inc.

Gas-Operated Device Clears Jammed Guns

The Kidde Pneumatic Gun Charger is designed to load or clear a gun within 1 sec. by the use of compressed gas. It will operate at temperatures as low as −65°F. and will supply sufficient charging force to cycle the gun bolt for any condition except total jam.

Model H-50 is a gas-powered, manually controlled device for charging 0.50-caliber Browning machine guns. The unit can be attached to either side of the gun, using the standard bolt stud that comes with the gun, and it can be demounted and remounted, including the high-pressure gas connection, in a few seconds, using only one hand and requiring no tools.

The charger is powered from a source of high-pressure gas, preferably compressed air, supplied from a small storage cylinder or directly from a compressor. Operating pressure may vary from 2,000 lbs. per sq.in. down to 250 lbs. per sq.in. When a storage cylinder of 57 cu.in. capacity is used, charged initially to 1,000 lbs. per sq.in., the charger will operate about 50 times before the gas supply need be renewed.

The charger action is initiated by a special two-way control valve. This valve may be either a simple manual control or an equivalent valve operated by a solenoid. Either type can operate several chargers simultaneously.

Where the type of installation permits, such as in turrets, the manual control valve is used because of its simplicity, lightness, and the elimination of interconnecting wiring. The solenoid control valve is ordinarily used where the guns are remotely located.

With the manual control valve, charging is effected by moving the valve lever and returning it to its original position after about a second's delay. When desired, the gun action can be held in retracted position by moving back the lever and allowing it to remain in that position as long as "hold-back" is desired. Returning the valve lever to its original forward position restores the gun to battery position.

When the solenoid control valve is used, pressure of a button initiates the operation of a piston, which in turn drives the gun action into a retracted position. When the control is released the charger exhausts, permitting the action to slam back into battery. The installation may be so made as to complete both actions automatically or, if preferred, so that the gun can be set for "hold-back" and held in that position indefinitely. The latter may be desirable for several reasons: for instance, after sustained bursts of fire, when holding the charge out of the breech would permit the gun barrel to ventilate and cool, thereby helping to prevent "cook-off" or accidental discharge; also, holding a shell out of the breech provides greater safety in landing and take-off, when a gun might otherwise be accidentally discharged by jolting.

The solenoid is equipped with two windings in series, one being the actuating coil and the other the holding coil. The actuating coil is momentarily energized and draws about 12.5 amp. at 28 volts. This double coil solenoid permits various types of wiring and control arrangements.

The Kidde pneumatic gun charger is constructed of steel, with aluminum and brass accessory parts; it is less than 18 in. in length and $1^3/_{16}$ in. in diameter and weighs slightly over 2 lbs. Walter Kidde & Company, Inc., Belleville, N.J.

Time Control for Electric Furnaces

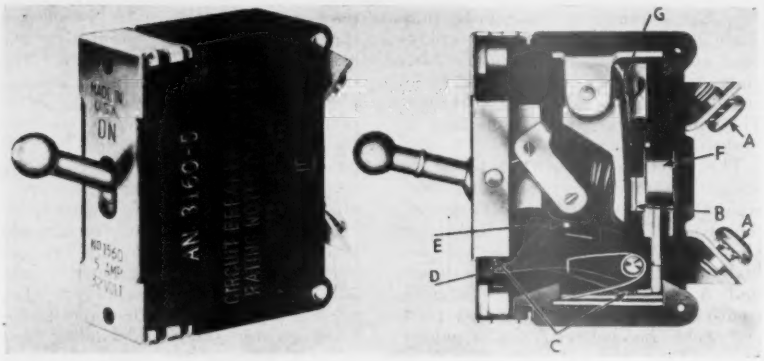
Called "Micromax Electric Control, Duration-Adjusting Type," a new system of control for electric furnaces and ovens regulates electric input to hold temperature at a selected control point or to a program.

By means of an "on-off" contacting system, it feeds to the heating unit the electric current needed to maintain temperature at the required control point or program. Input is either "full-on" or "full-off." Regulation is obtained by controlling automatically the time during which current is "on" and "off."

Employing the balance method both for measurement and control, this new system, like the position-adjusting type of Micromax electric control, is a completely coordinated one designed to give its users the full benefits of correctly applied control. It provides full proportional time action as compared with the more familiar full proportional positioning action. It can be equipped with overshoot control, which is used when the furnace or other unit is coming up to temperature. Leeds & Northrup Company, Philadelphia.

Fuse Panels for Aircraft

Littelfuse Universal Fuse Panel No. 1505 is reported to offer special advantages for use in airplanes. The panels can be placed at an accessible point rather than in a central junction box, so that under gunfire they can be replaced at the point where the crew man is. Their dispersal throughout the plane renders these panels less liable to damage. The circuit can be opened by pulling out a metal bar from the clips with insulated pliers.



The Littelfuse No. 1560 circuit breaker.

The new panel is for Littelfuse 3 A G and 3 A B, 4 A G and 4 A B, and 5 A G and 5 A B Aircorps Type of fuses and clips. One number covers the mounting. The user has only to take the blueprint and in a few moments check all the factors for panels precisely to his individual specifications. The first dash number indicates fuse specification. The second dash number specifies number of poles. Specifications include bus bars, if required, and number of poles to be bussed. Light, durable panels to individual specifications, meeting all Air Corps requirements, are delivered ready to mount, equipped with terminals and fuse clips or terminal studs. Littelfuse Incorporated, Chicago.

Temperature-Resistant Switch Breaker

A circuit breaker relatively free from the effects of extreme high or low temperatures is based on a new bimetal design in which the bimetal is used as a finger that pulls the trigger. No appreciable mechanical load is exerted on the bimetal as it trips the breaker.

The device was primarily designed for military use in aircraft that may be subjected to temperatures ranging from −65° to +180°F. The actual ambient temperature at which the breaker trips without a flow of current is 350°F. The high differential between operating and breaking temperatures is a characteristic of this circuit breaker.

The new unit, designated as No. 1560 (AN 3160), is of switch-type, nontrip free, intended to meet performance specification AN-C-77. The range is 5 to 50 amp. at 30 volts, a.c. or d.c. It is capable of breaking 2,500 amp. on short circuit. It meets the requirements of holding for 1 hour at 115 per cent of rated current; breaks within the hour on 138 per cent of rated current; breaks at 200 per cent of its load between 10 and 100 sec. These tests are all at the ambient temperature of 77° ± 1.8°F. The breaker is enclosed in a moistureproof black Bakelite case. It is panel-moun ed by two 6/32 screws, $^1/_4$ in. long, for $^1/_{16}$ in. thickness of panels equipped with heavy copper terminal bus bars. Overall size is $2^1/_8$ in., by 2 in. deep below panel, by $^3/_4$ in. wide. Littelfuse Incorporated, El Monte, Calif.

Dive Flaps to Combat Compressibility Effect

An invention from Lockheed Aircraft Corporation's laboratories is reported to have been successful in overcoming the effects of compressibility in power dives by airplanes. It was developed after 3 years of research by pilots and engineers of Lockheed and of the Army Air Forces.

The device is an improved form of dive flap, designed to control the flow of air across the wing to negate the phenomena of compressibility. It consists of two strips of metal hinged to the under side of the wing of the Lightning and controlled by a button on the pilot's control wheel. After a power dive from an altitude of 35,000 ft., the P-38 is reported to level off within 3,000 to 5,000 ft. after the pilot has begun to pull out.

Military security prohibits a detailed description of the Lockheed dive flaps, but it is understood that they have been successfully tested on another American fighter and are under test on a third. They have been in full production on the Lightning for months, and "flaps kits" are en route to the fronts for modification of earlier P-38 fighters.

The Lockheed dive flaps are stated to have achieved a solution to the difficulty caused by the compressibility effect throughout the tactical speed range of today's aircraft. When retracted, the dive flaps leave a "clean" wing that does not reduce the Lightning's speed. Extended, they do not materially reduce its diving speed, but they control it. Lockheed Aircraft Corporation.

Variable-Speed Drive

For modernization of old machinery the manufacture of a new, compact type of variable-speed drive offers new possibilities for use in the medium and higher horsepowers for geared-drive power transmission.

The unit is intended to provide an individual control for each machine. It is scarcely larger than the motor with which it is used, even in ratings of 15, 25, 50, 100 hp. or higher. The complete unit with the motor has the size and appearance of two standard a.c. motors coupled together. Differing from conventional types of variable-speed units, it uses the V-belt as a control medium only, rather than for both drive and control, primary speed reduction being accomplished by conventional gearing methods.

The maker states that through this new gearing arrangement 90 per cent of the power goes through conventional gears while only 10 per cent passes through the V-belt. The lower gear ratio affords finer control. Low maintenance is made possible because the easily accessible V-belt is the only part likely to need replacement over a long period of time. Having the variable-speed output shaft concentric with the motor shaft gives it the advantage of a direct-line drive. Remote control is also available, with horizontally split castings optional. Lombard Governor Corporation, Ashland, Mass.

Universal Clamp

A stainless-steel flexible-band type hose clamp designed for aircraft use is known as the Universal Series 820. It is stated that the clamp has passed all requirements of AN-FF-C-406a hose clamp specification at the Naval Aircraft Factory.

Special construction features include a patented swivel-action nut that rocks on swivel pins and tips down when the thumb screw is tightened. This clinches the band, prevents slipping, and gives a high back-off torque. The clamp is claimed to be vibration-proof and to remain tight under all conditions

The construction permits re-use. The band and saddle are of stainless steel, and the screw, nut, and pad are made from plated alloy steel. The clamp can be installed or removed without tools. Three standard sizes are available to cover the range of AN748 sizes 22 to 114, inclusive. The series 820-12 fits hose $^{11}/_{16}$ in. to $1^3/_{16}$ in. outside diameter; the series 820-14 fits hose $1^3/_{16}$ in. to $2^9/_{16}$ in.; and the series 820-16 fits hose $2^9/_{16}$ in. to $3^9/_{16}$ in. Other sizes may be had on special order. Marman Products Company, Inc., Inglewood, Calif.

Beaching Gear for Large Seaplanes

A method for the rapid and safe beaching of large seaplanes without employment of the usual number of men in the landing crews has been devised at the Naval Air Station at Banana River, Fla.

The installation consists mainly of a ferry-type slip mounted on floats, a set of guides, a cradle car, and rails. A turntable approach section may be substituted for the ferry slip. Both turntable and slip conform automatically to the tide and are adjusted to wind direction by means of winches. The guides are adjustable to various sizes of seaplanes. Need for men to swim or wade into cold water with beaching gear is eliminated. The whole beaching operation is handled by the pilot and one or two men on the beach.

The seaplane approaches the ferry slip or turntable in the same manner

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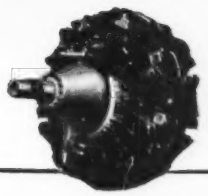

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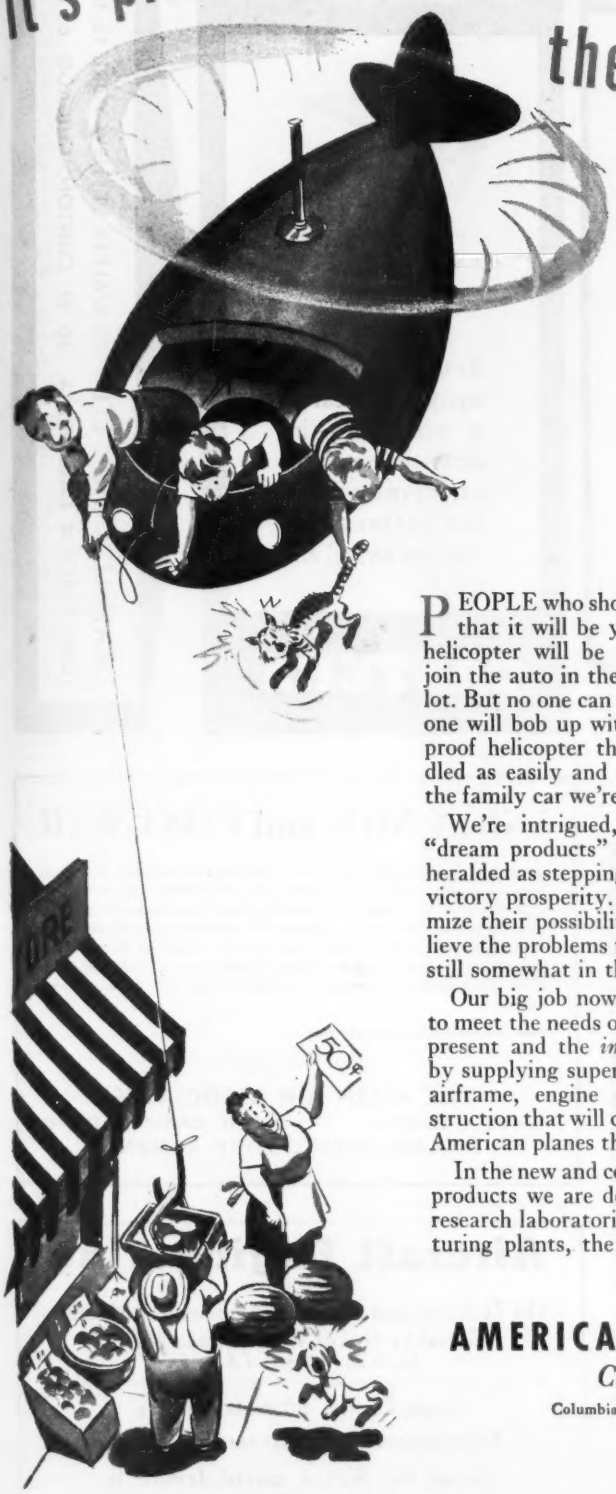

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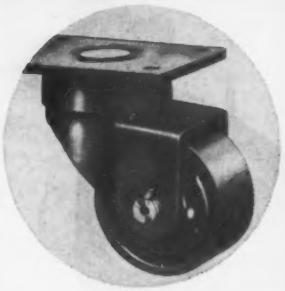

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as it would approach a beaching buoy. As the plane enters the slip or turntable, it is turned until aligned with the guides. Taxiing forward, the plane assumes a position directly above the cradle car. A hook suspended from the tunnel hatch then engages an extension on the rear of the cradle car. As plane and cradle car move forward between the guides, the car begins ascent of an incline, bringing the plane gently to rest upon the cradle. The plane may go up the side under its own power or with the help of a winch. On the beach it may be moved rapidly on tracks to loading platforms and maintenance stalls. For launching, the hook is removed and the plane taxis over the side, the car dropping away when the plane becomes water-borne.

Approach and guide units may be used as aircraft docks by adding bumper nose and sidewalks on the uprights. Need for rails for the cradle car may be eliminated by use of air wheels running in U channels. The inventor has constructed a working model using a model of the PBM Mariner for demonstration purposes. He states that a seaplane designed for beaching with this gear could be made lighter because there would be no need for heavy beaching-gear fittings on the hull. Also, the weight of the plane would be distributed over a greater area when not waterborne, and the need for constructing the hull to meet beaching-gear stresses and strains would be eliminated. The Glenn L. Martin Company.

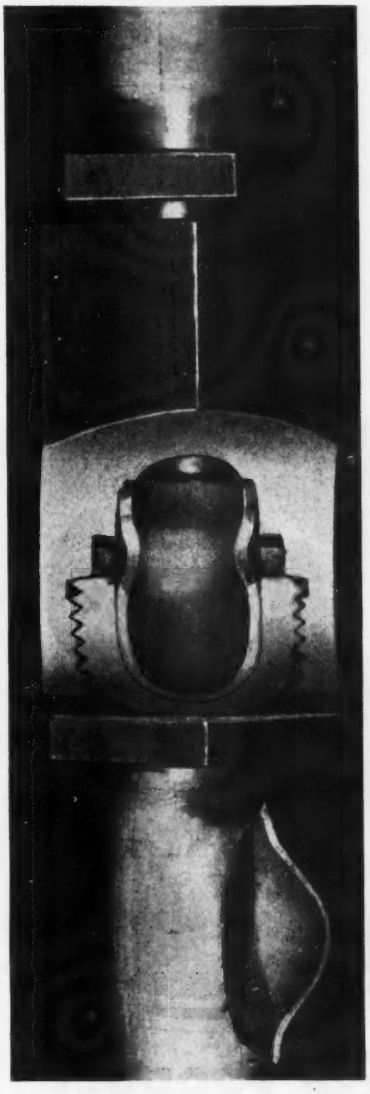
Lightweight Retractable Landing Gear

A patent for a lightweight retractable landing gear has been granted to the inventor and assigned to The Glenn L. Martin Company.

The new gear, which incorporates many novel features for bracing and locking in the down position, has already proved itself in service on the A-30 Baltimore, withstanding months of desert operation from improvised landing fields with a minimum of maintenance. In the A-30 installation the weight of the main gear was only 897 lbs. as compared with the 19,000-lb. gross weight of the airplane, a landing-gear to gross weight percentage of about 4.72.

The gear is supported by an N-strut attached to the forward wing spar where it passes through the engine nacelle. This strut can be made as a single forging, eliminating many of the small assemblies found in other types of landing gear. The oleo is attached to one end of a trunnion shaft turning on bearing in the N-strut and braced by a single cross brace from the other end of the trunnion shaft. Direct connections from the oleo operate the wheel-well doors, eliminating the need for additional hydraulic mechanisms.

The raising and lowering of the gear is actuated by a hydraulic cylinder that moves an arm or crank attached to the oleo, which rotates it about the trunnion shaft as a pivot, up and back to flight position and down and forward for landing and take-off.



Connected with a new type hydraulic fitting developed by The Glenn L. Martin Company, this piece of $^{5}/_{8}$-in. diameter by 0.049-in. wall aluminum tube burst under a 5,000 lbs. per sq.in. pressure, but the fitting and joint were unaffected. Cutaway portion shows the principle of the new fitting in which a rubber sealing is compressed with such force by turning up the gland nut that it beads the tube and permanently seals the joint.

What is probably the most unusual feature of the design is the drag strut by means of which the gear is locked in down position. The forward end of this strut is attached to the oleo, while the aft end is fixed to a trolley running on a track on the under side of the wing inside the nacelle. While the gear is in the process of being raised or lowered, this trolley runs free, but as the gear reaches the down position, a block on the trolley engages a hooklike fixture that is part of the main structure of the airplane and lifts the wheels of the trolley off the track, transferring the landing or take-off load to the main structure.

At the same time, a square pin with one beveled edge engages the trolley and is pushed into place by a hydraulic cylinder, locking the trolley to the main structure, and through the drag strut, locking the gear into down position. When the gear is raised, the cylinder withdraws the pin and the trolley slides back along the track as the gear retracts. The Glenn L. Martin Company.

Loading Rack for Anodizing

Adjustable racks designed by employees in the Finishing and Plating Department have almost cut in half the time required to load work for anodizing at The Glenn L. Martin Company plant in Baltimore. In addition, the use of these racks in place of spring hangers for all tubes, formed parts, and heavy-gauge flat work has resulted in substantial savings in electric current and has permitted a far greater utilization of the available anodizing tanks because it facilitates the orderly arrangement of the parts.

There are two basic types of rack, each being made in several sizes so that by using them singly or in combination practically every size and type of part can be handled. The first type of rack has an aluminum-alloy center post with a frame at the bottom on which parts can be stacked around the center post and with a pressure plate at the top to hold the racked work in place. The top edges of the bottom frame are toothed to keep the work from slipping, and the pressure plate is adjustable and held in place by a spring and pin inserted in holes in the center post. The top of the center post is in the form of a hook to permit easy handling with an overhead conveyer.

The second type of rack has two posts with a fixed channel section separating them at the bottom and a movable similar section at the top. Top edges of the lower section and bottom edges of the top section are toothed to prevent slipping. Work is loaded on the bottom section, and the top is clamped down to hold it in place in a manner similar to the single-post racks. In loading parts that would cover each other, such as large corrugated sheet, smaller parts are used as spacers, thus utilizing the solutions to the utmost and avoiding to a large extent their waste on handling equipment.

The new racks are simple and durable and provide a sure and positive electrical contact. Where the former spring hangers had to be cleaned after each usage and soon lost their temper and springiness, the new racks have an almost indefinite life because only the bottom frame has to be cleaned after usage. Since this frame is of straight, rigid metal construction, it is easily cleaned and unaffected by the cleaning bath. The Glenn L. Martin Company.

Hydraulic-Tube Connection Method

A hydraulic-tube connection that eliminates the tube-flaring operation required with previous fittings provides greater resistance to vibration breakage while simplifying installation procedures both in the shop and in the field. It is being made generally available through licensed manufacturers. While designed to meet specific needs of the aircraft industry, the new fitting, which provides a firm, leakproof joint and can be used with both low and high pressures, is equally adaptable to the requirements of other types of hydraulics.

The new fitting is simple in design and can be fabricated in large quantities at a minimum cost. Basic parts consist of the fitting, a gland nut, a small metal collar, and a synthetic-rubber sealing ring. The fitting is bored in four concentric diameters, corresponding respectively, from the center out, to the inside diameter of the tube, the outside diameter of the rubber ring and metal collar, and the outside diameter of the gland nut, with the outside section threaded to take the gland nut.

To install the new fitting, the gland nut, metal collar, and rubber ring are placed over the end of the tube in that order and the tube is inserted in the gland as far as it will go. By turning up the gland nut, force is exerted on the rubber ring, with the metal serving to keep the nut from tearing the ring. Since the sealing ring is confined and rubber is not compressible, the axial thrust so developed grips the tube and actually beads it. At the same time, the rubber is forced into every crevice to form a perfect seal and exerts an outward force on the gland nut, locking the threads. The beading operation is "foolproof" in that after the proper bead has been accomplished the gland nut bottoms in the fittings and further crushing of the tube is impossible.

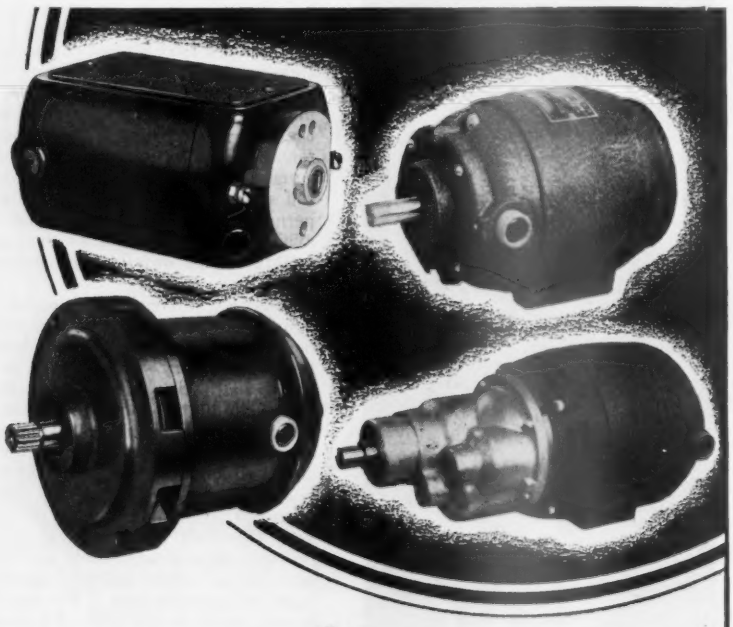
By eliminating the flaring operation, the new fitting removes one of the main causes of hydraulic-line failure, since this operation often affected the structure of the metal, bringing about tube failure caused by vibration in service. At the same time, it does away with the need for beveling the end of the gland nut, a relatively difficult machining operation, and permits the use of higher-strength alloys than 52SO where desirable. From the standpoint of installation, the elimination of the flaring operation ends special preparation of the tubes, a timesaver in the shop, and often determines whether a repair can or cannot be effected in the field. With the new fitting all parts except the rubber ring may be used many times. Another advantage is provided in that with the new connection the fittings may be standard and have varying-width compression rings for varying pressure requirements, thus reducing the number of separate replacement items that must be carried in stock.

Tests have demonstrated the high-pressure resistance and other characteristics of the new fitting. On $^5/_8$-in. diameter by 0.049-in. wall aluminum-alloy tube installations, pressures as high as 5,000 lbs. per sq.in. have been successfully withstood, while on $^3/_8$ by 0.035 tube the pressures have run up to 6,200 lbs. per sq.in. In both instances it was the tube itself rather than the fitting or joint which failed.

In another test, $^3/_8$-in. steel and aluminum tubing were assembled in a double fitting and vibrated under 1,500 lbs. per sq.in. pressure for 25 hours with no evidence of leakage. From the mechanical-tension standpoint a 1,000-lb. pull was withstood by the steel-tube installation and 400 lbs. by the aluminum. Torque required to install a $^3/_8$ fitting was 200 in.lbs. for aluminum and 900 in.lbs. for steel. Laboratory tests have further revealed that pressure loss caused by restriction is negligible because of the smooth contour of the restricted area. The Glenn L. Martin Company.

Taper Attachment

A taper attachment of simplified design is designated "The Master Taper Attachment." It is designed to make possible accurate taper turning, boring, and threading. It may be used in any position on a lathe and does not interfere with straight turning. The sliding fixture has straight gibs, eliminating vibration and tool play. Graduations are in inches at one end and in degrees at the other end of the swivel bar. It



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"We should like to express to you our complete satisfaction with the performance of Champion Spark Plugs . . . we were able to obtain the remarkable service of 100 hours between changes . . . they required at least 50% less time to service for re-installation, since they could be cleaned and re-gapped without dismantling and with the simplest of maintenance equipment." *Excerpts from a letter from JOHN E. KEVARI, Superintendent of Maintenance, Southwest Airways Cargo Division.*

OVER 1,000,000 MILES OF FEEDER LINE OPERATION!

Southwest Airways Cargo Division inaugurated an exclusive feeder line service for the ATC just 21 months ago. Its outstanding success, unmarred by accident, and with the safe and speedy delivery of over 2,000,000 pound cargo proves conclusively and dramatically the practicality of true feeder line service.

In this operation Southwest Airways are deserving of credit as genuine pioneers. They have foreshadowed by a million miles plus, the type of short haul operations that will inevitably link thousands of the nation's small towns into a vast network of speedy and sure transportation.

The "ups and downs" of this service, over 2600 route miles per day, totalled 28,000 landings and take offs. Loads consisting of war materials with high priorities, military freight and mail demanded the utmost in dependable service at all times. Champion-Ceramic Spark Plugs played their vital part with conspicuous success as attested to by the above excerpts.

DEPENDABLE

CHAMPION SPARK PLUGS

CHAMPION SPARK PLUG COMPANY, TOLEDO 1, OHIO

INSTALL CHAMPIONS AND FLY WITH CONFIDENCE

tapers up to $3^1/_4$ in. per ft., $16^1/_2°$ maximum in either direction. $7^1/_2$ in. in length at one setting. It duplicates tapered parts for accurate production.

The device can be attached or removed readily. It is reported to be available for immediate delivery to fit the following lathes: Logan 10 in., Atlas 10 in., South Bend 9 in., Sheldon and Clausing. Taper attachments for other lathes are manufactured to order. Master-Taper Company, Chicago.

Large-Scale Production of Army Helicopters Begins

It is reported that plans have been completed for quantity production, in a plant of Nash-Kelvinator Corporation, of the Sikorsky R-6 helicopter, a joint Army-Navy development. It is a single-rotor type of helicopter, having three blades, with a tip-to-tip diameter of 38 ft. The three blades of the auxiliary tail rotor have a tip-to-tip diameter of slightly more than 7 ft.

The Nash-Kelvinator-built helicopter has a top speed in excess of 100 m.p.h., carries sufficient fuel for a flight of 5 hours, and will climb to 4,000 ft. in less than 7 min. Normal gross weight of the craft is 2,600 lbs. Ambulance litters can be carried in capsules placed on either side of the fuselage, with the alternative use of twin bomb racks. The cabin is soundproof and heated.

The new helicopter is a two-place aircraft with dual flight controls. The pilot's cabin is at the forward section of the streamlined fuselage, all metal except for cabin-section supports which are made of molded plastic-impregnated glass fiber cloth, mounted on an aluminum floor. The tear-drop nose of the new helicopter is said to be the largest single piece of Plexiglas of its type and is similar in appearance to installations on some bombers. Other Plexiglas panels surround the pilot's cabin, providing broad visibility. Landing gear is conventional, with two main wheels having cantilever struts, with a small tail wheel midway between nose and tail and a nose wheel to prevent nosing over. The helicopter is equipped with a high-frequency radio communications set. Power is furnished by an air-cooled Franklin 245-hp. engine, which drives the main rotor as well as the tail rotor.

A drive-shaft and transmission mechanism directly above the engine connect it to the rotor head and three main rotor blades. A smaller rotor, mounted at the left side of the long conical tail section, provides directional control. Nash-Kelvinator Corporation.

Eight-Gun Nose for B-25

The addition of an eight-gun nose to the attack-bomber model of the B-25 increases its fire power to 18 0.50-caliber machine guns. This new version of the Mitchell is being built at North American's Kansas plant, which is doing the unusual job of producing two versions of the same bomber from the same production line.

The new eight-gun nose gives the medium bomber 14 forward-firing machine guns, including the pair in the upper power turret. Besides the octagonal nose cluster, the plane has four guns in "blisters" on either side of the fuselage. All twelve of the fixed guns are fired by the pilot.

In addition to the twelve fixed forward-firing guns and two upper-turret guns, the Mitchell has four other 0.50-caliber guns, two in the tail turret and two in the waist. With this total of 18 machine guns, the bomber can attack or defend itself in all directions aloft and fire upon a wide area on the ground.

A full load of bombs is carried on both versions of the B-25, but in the eight-gun-model the bombardier's controls are placed so that bombs can be released by the pilot. North American Aviation, Inc.

The Bendix Aviation Corporation's Geneva-loc electric positioning actuator.

Electric Positioning Actuators

Geneva-loc positioning actuators are intended to provide accurate control within 1° of any series of operations up to eight positions, with each position positively locked against movement. They incorporate a Geneva movement operated by a high-speed motor. Positioning by limit switches has been eliminated. Five advantages are reported: (1) positive control of output shaft movement, which automatically locks at all stops and which is independent of motor overtravel and temperature variations; (2) no clutches, torque limiters, brakes, or adjustable limit switches; (3) motor comes up to speed under no load, then engages cam with varying ratio which develops maximum torque at breakaway positions; cutout switches always operate when motor is under no load, permitting maximum switch life; (4) design permits two to eight positions; (5) entire unit can be disassembled and reassembled or interchanged quickly in the field. There are no limit switches, brakes, etc., to be adjusted.

Geneva-loc actuators are designed for remote operation of hydraulic valves, two-speed supercharger controls, fuel-selector valves, spark retard, propeller feathering, air-duct valves, or any similar installation where accurate positioning is desired. Pacific Division, Bendix Aviation Corporation.

New Lightweight 700-Hp. Aircraft Engine

A new compact, lightweight Ranger aircraft engine has been developed for postwar commercial aircraft, especially in the feeder-air-line field. Weighing 870 lbs. complete with standard accessories, the engine develops 700 hp. for take-off with 100-octane standard fuels, producing nearly 1 hp. for each cubic inch of piston displacement. The engine is a twelve-cylinder, inverted, air-cooled "V" type having an overall height of 31.11 in. It is 74.92 in. long and 33.28 in. wide.

Cooling is accomplished by the pressure of air entering a scoop and directed around the cylinders by an arrangement of baffles, which create turbulence in the air flowing around the cylinders. Aluminum cooling fins are chemically bonded to the steel cylinder barrels by use of the Al-Fin process. It is stated by the builder that a minimum of air is required for successful cooling and that this fact, coupled with the compactness of design, makes the engine suitable for "submerged" installations. Designed for ease of overhaul and low-cost maintenance, the "V" construction gives easy access to all spark plugs, ignition wires, manifolds, and air baffles. Entire assembly units can be removed or installed intact. All accessories are placed where they may be conveniently reached for service.

Basically, the new engine is composed of five major units: the crankcase and cylinders, the right and left cam boxes, the nose section, and the rear section. In disassembling, all can be removed by a single mechanic without the use of a chain hoist and with a minimum of time and special tools.

Power sections are made of aluminum alloy. The six-throw crankshaft is dynamically balanced and connecting rods are of the fork-and-blade type. Overhead camshafts actuate the valve mechanisms on each bank of cylinders. Ignition is by high-tension dual magnetos. The fuel induction system is designed around a new, advanced type of pressure carburetor. Pressure lubrication is of the dry-sump type. Oil is transferred through drilled passages. The hollow accessory drive shaft is the main oil gallery. Splash and spray of oil lubricates the cylinder wells, pistons, and piston pins. Valve mechanisms are pressure lubricated.

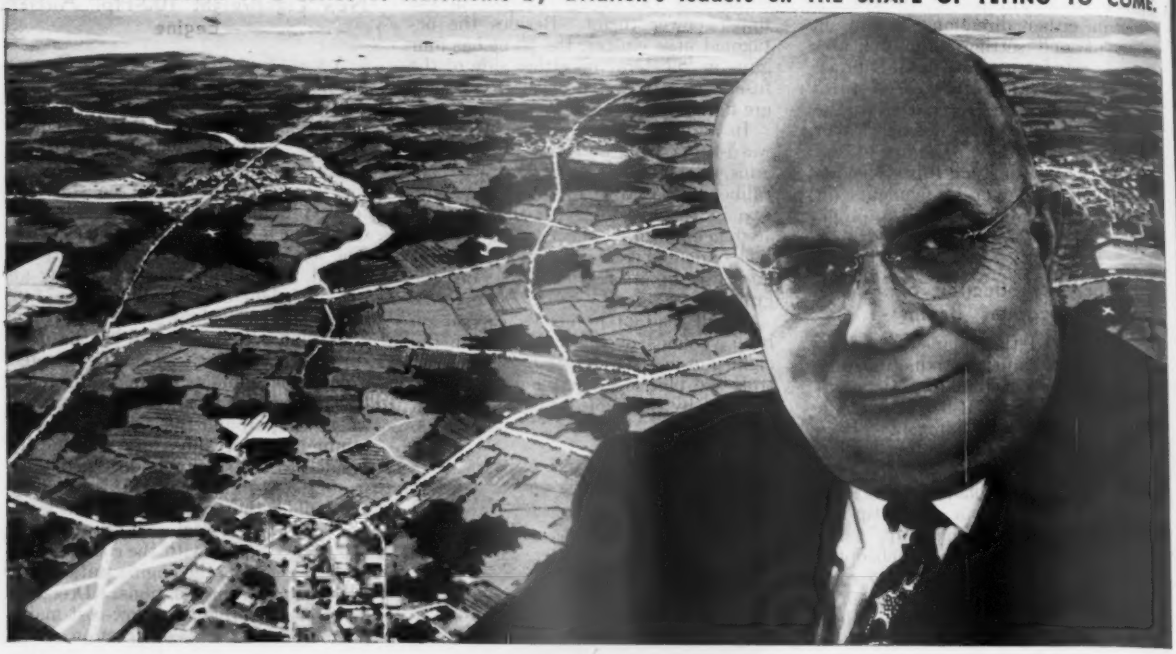
The engine will be available with two propeller reduction-gear ratios: 1.65 to 1 and 2.37 to 1. Planetary reduction gears are employed. At 3,600 r.p.m. for take-off, the propeller shaft speed is reduced to 2,180 by the first ratio and to 1,520 by the second.

The new engine will be ready for peacetime applications as soon as the war ends. It bears the company's commercial designation SGV-770-D-5. Ranger Aircraft Engines Division, Fairchild Engine & Airplane Corporation.

Hy-Speed Precision Punch Press

Combining the features of the "V"-way vise and the gap-style press, a new

This is the sixteenth of a series of statements by aviation's leaders on THE SHAPE OF FLYING TO COME.



"Let's put our most dynamic capital to work!"

says HENRY J. KAISER, *President, Henry J. Kaiser Company*

"AMERICA'S MOST DYNAMIC CAPITAL-INVESTMENT *is in the million or more young men trained to live and work in the air, to manufacture and service airplanes. These pioneers can open a great new chapter in transportation, in the accelerated evolution of American industry. But will the aviation industry, with its record of daring and achievement, give them their opportunity?*

"The answer is 'yes!'—if it gets moving now. Let industry, with Government encouragement, take on a pre-selling program for airplanes, accept orders at fixed prices for postwar delivery; and let labor enter now into postwar contracts.

"With that head start, there is no economic or technological reason why the aviation industry, which produced 3555 personal airplanes in 1939, and 7700 of them in 1941, should not in the first two years after the war manufacture and sell a minimum of 50,000 personal airplanes, perhaps as many as 150,000. And it is not visionary to picture the manufacture and sale of a million personal planes during the next ten years —and 5000 terminals to house and service them."

Magnificent are America's opportunities-in-the-air, Mr. Kaiser. But these opportunities will not be fully realized until they have been *sold* as down-to-earth practicalities.

And the first place to sell them is to the "test pilot" market of U.S. people who are ready to buy progress whenever they see it in business or private living.

This is the market that aviation thinks of when it thinks of the more than a million* TIME*-reading families—*who are America's best prospects for planes and air travel—whose positions in American business make them the natural national vanguard for any programs aviation may set up—who vote* TIME *their favorite magazine 7 to 1 over the runner-up.*

Believing that the ideas of aviation's leaders are always of interest to the aviation industry, TIME here gives them wider circulation in the name of

AVIATION'S SILENT PARTNERS

TIME

THE READERS OF TIME

precision bench press is of semisteel construction. Incorporating "V" ways to eliminate the use of die shoes, the the new press is designed for a more speedy and efficient handling of many production jobs. It is made in one size, 5 tons, and has a 5- by 6-in. platen with 7 in. of ram movement.

Only two levers are used in the hydraulic foot control: one to apply pressure up to the rated tonnage; the other for release, which has a two-speed return. No outside air line or power is needed and the unit is self air-eliminating. The operator's hands are free when operating.

The machine is adaptable, with proper equipment, to be used as a tensile- and compression-testing unit up to 5 tons, as a pipe vise to handle up to 6-in. pipe, or as a shear for 1/4-in. plate or 1/2-in. rounds. Further uses to which the unit can be adapted are marking, notching, riveting, crimping, mounting samples, etc. Reimuller Brothers Company, Franklin Park, Ill.

Ball-Point Accessory for Visual Gauges

A standard ball-point accessory for Sheffield visual gauges for rapid production checking of pitch diameter on threaded parts has been developed for use with the maker's 500-1 and 1000-1 models. Accuracy is said to be comparable for practical purposes to that of the three-wire method, but the inspection operation is many times faster.

The accessory includes a chromed bracket and adjustable backstop with a thread-checking ball point of tungsten carbide mounted in the bracket. A second identical tungsten-carbide ball point is provided in the visual gauge spindle. The accessory has a capacity of 1-in. maximum work diameter and is set up with threaded masters instead of gauge blocks.

Three pairs of ball points equivalent to the best wire sizes for 36, 20, and 12 threads per in. are furnished as standard with the accessory, and threaded parts can range from 11 to 56 threads per in., and up to 1 in. in nominal size can be checked. Pairs of ball points in other sizes are available. The Sheffield Corporation, Dayton, Ohio.

Small Tachometer

A tachometer that weighs only 5 1/2 oz. and is 2 1/4 in. in diameter permits one-hand manipulation. The recording in r.p.m. is read without the use of any timing, or counting device. The scale is made up of black figures against an orange background.

The range of this instrument runs from 500 to 3,000 r.p.m. The makers state that stock models show a variation of less than 3 per cent from absolute accuracy over the whole range. Standard units have been subjected to 50,000 test readings without recording any variation in the accuracy of the readings from start to finish.

A pointed contact spindle is a part of the instrument for use with shafts that are centered, and an elastic tip is furnished that will slip over the pointed spindle for use on shaft ends that are not centered.

The tachometer is dust- and moistureproofed and has a baked enamel protective coating on all surfaces except the scale, which is enclosed in a plastic tube. The Standard Machinery Company, Providence, R.I.

Power Plants for New Air Liners

The Douglas DC-6 transports included in the recent contracts for postwar equipment for several of the air lines will be powered by an advanced design of the Pratt & Whitney Double Wasp engine. It is designated as the R-2800-C, which produces 2,100 hp. and is already in production. The previous model of the Double Wasp—the R-2800-B—has been used in the Curtiss C-46 Commando, the Martin B-26 Marauder, and the Lockheed PV1 Ventura. This engine also powers three of this country's current fighters, the Army's Republic P-47 Thunderbolt, the Navy's Grumman F6F Hellcat, and the Vought F4U Corsair. Other planes using the Double Wasp include the Northrop P-61 Black Widow and the British Vickers Warwick I.

The Double Wasp was put into production originally at East Hartford in 1939, just two years after design had been undertaken. Soon an improved series—which raised the horsepower from 1,850, the original rating, to 2,000—was in production. Then a third series, the R-2800-C, with a basic output of 2,100 hp., was built. This is the engine which will be used in the DC-6.

The DC-6 will have three-bladed Hamilton Standard propellers of the paddle type, with a diameter of 13 ft. 2 in. United Aircraft Corporation.

Plastic Cabin Structures for R-6 Helicopter

Plastics are being used for the cabin structures of the new R-6 helicopter. The plastic material was chosen for the cabin structures because of its light weight, only half that of aluminum of similar thickness, together with its tensile strength, rigidity, ability to withstand strains and vibration. It met specifications of the A.A.F. for this new structural use after it was put to many rigid tests.

Made of Fiberglas, laminated and reinforced with thermosetting resin, the composite material is a nonconductor of electricity and is not affected by gasoline, oils, acids, most alkalis, alcohol, or fungus growth. Another feature is that it retains all of its properties in sub-zero temperatures as well as in excessive heat. As far as is known by the producer, this is the first use of laminated plastics on a production basis in this type of construction. United States Rubber Company.

Weighing only one-seventh as much as cork, plastic "Flotofoam" is now being manufactured for important war uses by the United States Rubber Company.

Lightweight Plastic Foam

"Flotofoam" is a synthetic plastic foam weighing only one-seventh as much as cork. It has been developed and is being manufactured for important war uses. Peacetime uses foreseen include insulation for airplanes, trains, automobiles, and homes. In lifesaving equipment such as life preservers and floats and as buoyancy units on water craft, this plastic foam will provide great buoyancy with minimum weight.

This material is produced by a process under which a combination of synthetic plastic materials is foamed and then solidified. It is semirigid because it contains so much air space. It has good insulation and sound-deadening properties in comparison to its weight. In its present form it weighs less than 1 1/2 lbs. per cu.ft. and can be made to weigh as little as 3/4 lb. per cu.ft. United States Rubber Company.

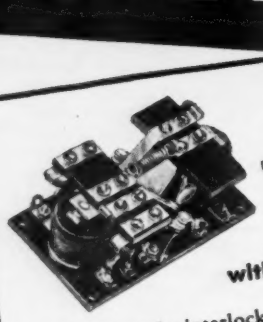
Lighting Problems of a Large Assembly Plant

The problems of lighting a large aircraft-assembly plant were discussed in a paper by J. L. Kilpatrick of the Westinghouse Electric & Manufacturing Company and L. N. Blugerman of the Edward G. Budd Manufacturing Company delivered at the annual meeting of the Illuminating Engineering Society in Chicago. It refers to the new plant of the Budd company known as Budd Field at Bustleton, Pa.

The design selected for this building comprises a structure made of steel-reinforced concrete nearly 600 ft. wide and 1,800 ft. long. The entire assembly area is all on one floor and its walls enclose over 24 acres of ground. In plan, the area consists of two sections each approximately 135 by 1,800 ft. (designated "high bays") and six sections each approximately 50 by 1,800 ft. (designated "low bays").

Each bay has a vaulted roof made up of a compound curve which gives an appearance of a somewhat flattened section of a cylinder with a ceiling of smooth concrete. In the high bays the roof is supported by columns approximately 7 ft. by 2 ft. 6 in. In the low bays the the supporting columns are 2 ft. 3 in.

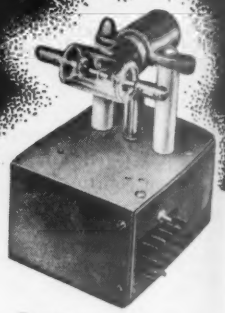
FIVE OF THE 5,312 RELAY TYPES



A NEW "MEMORY" RELAY

with simplified interlock

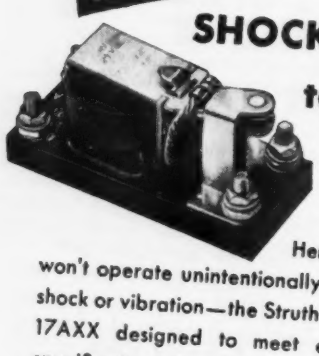
A new style interlock represents latch-in relay construction in its simplest, most dependable form. Design of this Struthers-Dunn 50XBX series simplifies make-before-break, or break-before-make contact combinations. Contacts do not interrupt coil circuit until the "throw" is completed and they are latched in new position. Built to aviation specifications.



VACUUM SWITCH KEYING RELAY

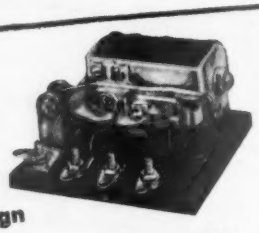
The extreme reliability with which this Struthers-Dunn Type 78CCA100 Vacuum Tube Keying Relay holds its adjustments is the direct result of a rigid and simplified design utilizing an absolute minimum of parts. Exceptionally sturdy—designed for aircraft. All parts readily accessible.

7 poles including one D.T. pole handling high-voltage r-f currents by means of a vacuum switch. High-voltage parts rounded to reduce corona.



SHOCKPROOF to 90 G's

Here's a relay that won't operate unintentionally as a result of shock or vibration—the Struthers-Dunn Type 17AXX designed to meet exacting B2A specifications. Small in size, light in weight, it meets and exceeds all specifications for such services.



SENSITIVE SNAP-ACTION

In a new, simplified design

Applications for the Struthers-Dunn Type 79XAX Sensitive Snap-Action Relay range from vacuum tube circuits, to overcurrent protection, pulsing circuits, and jobs where extremely close differential or extreme sensitivity are required. Contacts remain in position *with full pressure* up to the instant of transfer. Write for Bulletin No. 251.

EXTRA HEAVY-DUTY CONTACTS

Struthers-Dunn Nutcracker Type 61HXX100 meets the call for relays for extreme services, particularly where severe overloads may cause trouble on units having a less generous heavy-duty contact safety factor. Typical applications include those such as aircraft landing light controls, or controlling a number of solenoids simultaneously. Readily adaptable to different specifications.

***WRITE**—for your copy of the big Struthers-Dunn Relay Catalog and Data Book . . .*

STRUTHERS-DUNN, INC., 1321 ARCH ST., PHILA. 7, PA.

STRUTHERS-DUNN
5,312 RELAY TYPES

DISTRICT ENGINEERING OFFICES: ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND
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by 3 ft. All columns are regularly spaced along the longitudinal element on 40-ft. centers. Except for these supporting members there is almost no other structural interference in the entire building.

The vaulted ceilings have no beams or other obstructions with the exception of two rows of skylights in the large bays and one row of skylights in the small bays, together with suspension rods to support craneways and a monorail system throughout the entire plant. In the high bays, the maximum height to the zenith of the arch is 58 ft., with a minimum mounting height for lighting equipment of 41 ft. above floor level required for clearance of the conveyer systems. In the low bays the maximum height to the zenith of the arch is 33 ft., with a minimum mounting height for lighting equipment of 23 ft. 6 in.

After a detailed analysis of the problems and the possible types of equipment suitable for the purpose, a description is given of the unusual design selected, which was an indirect lighting system using 3,000-watt mercury-vapor lamps. The complete installation is described at length, with information about the initial cost, operating and maintenance expense, and the results obtained. Westinghouse Electric & Manufacturing Company.

Gun-Sight Lamp

A gun-sight lamp that enables American gunners to aim directly into the sun's rays and yet fire with accuracy has been developed for the Army and Navy for protecting airmen against enemy planes that dive out of the glare of the sun to attack. The miniature lamp is being produced for all types of optical gun sights as well as for torpedo directors. The manufacturer states that present gun sights allow gunners to aim within about 15° of the sun, leaving a "blind spot."

With this new lamp illuminating his gun sight, the sight lines or reticle will be visible even against a glaring sun and it will no longer be necessary to use a dark filter that tends to obscure the target. About the size of a walnut, the new lamp provides light reported to be from eight to 30 times brighter than gun-sight lamps now in use and does so with the same filament wattage. In some of the lamps, the wattage has been reduced by as much as 60 per cent and yet the advantages of more brilliant light have been retained.

Tropical warfare, particularly, revealed a need for gun-sight improvements. In the tropics the sunlight is more brilliant, especially at the high altitudes where much of the aerial warfare is carried on. With present gun-sight lamps the reticle image sometimes becomes lost in the glare. The two favorite attack positions of warplanes are between the target and the sun or between the target and a bright cloud near the sun, because a cloud reflects light and is brighter than surrounding sky. To reduce the glare of the sun, dark filters were placed in front of the gun sights. These filters not only darkened the sun but also obscured the target by about 50 per cent. Equipped with the new lamp, the gun sights now can be used without filters, giving a clear image of the reticle without darkening the target whatever.

The brilliancy of the gun-sight lamp can be controlled by the gunner according to the demands of the situation. At night, for example, the lamp can be dimmed so that the sight lines will be clear and yet not so brilliant as to obscure the target; in sunlight, the lamp can be made brighter to provide a vivid image of the reticle. Westinghouse Electric & Manufacturing Company.

The Zephyr collet chuck drill adaptor.

Electronic Oscillograph for Study of Ignition Problems

The electronic beam is being used to record airplane-engine ignition action to help solve the problems encountered in producing faster and more powerful engines. The electronic device that guides the electrons in their new task is the Westinghouse cathode-ray oscillograph, once exclusively a laboratory tool but now built on a commercial basis for use on the production lines of the nation's war plants. Among war plants now using it are the Scintilla Division of Bendix Aviation Corporation and the American Bosch Corporation.

The new electronic oscillograph takes pictures on ordinary camera film and makes its impressions in much the same manner as an X-ray. The beam of electrons is created by a high-voltage rectifier. To prevent the beam from registering on the film before the ignition study is made, the device incorporates a beam trap that deflects the electrons out of the photographic channel.

The electrical impulses to be studied are shot across the path of the electronic beam just above the film rack. The impulses force the electronic beam out of its straight path and cause it to place on the strip of photographic film a record of the voltage. Simultaneously, the electron pencil records the time involved to give engineers a graphic record of electrical events that occur in periods as short as one hundred-millionth of a second. The fastest speeds are photographed on a stationary film strip, but slower speeds, of less than eight millionths of a second, are recorded on a revolving drum that turns at 7,000 r.p.m because fixed film will not register "long" times like one-fiftieth of a second.

Westinghouse research engineers collaborated with aircraft-engine manufacturers in testing ignition systems with the oscillograph and the results led to improvements that have overcome ignition trouble. Westinghouse Electric & Manufacturing Company.

Program Timer

The Zenith Program Timer is designed for numerous uses in factories, airports, railroads, schools, hotels, and other institutions. It is an automatic switch that can be set to close an electrical circuit at any desired 5-min. interval as often as desired. As many as 288 operations per day are possible.

The program mechanism is set by turning the minute hand as on an ordinary clock. The schedule is easily changed at any time without the use of tools. Small spring-brass clips are inserted in slots of the program disc for the program desired. These pins select the operating times. Timing is performed by a set of cam-operated contacts that operate with snap action. A synchronous motor, which has a rating of 10 amp. at 110 volts, powers the device. The steel case measures 8 by 12 by 4 in. Zenith Electric Company, Chicago.

For Continued Use of Broken Drills

One of the ingenious little tools developed in an effort to conserve tools is a positive-drive collet chuck drill adapter that permits the use of broken flute ends of twist drills. Drills are held securely and concentrically without threading or soldering. Special tools are not required.

A simple flat notch is rough-ground on the broken end of the drill before insertion into the collet. The notch slides past a pin located at the bottom of the collet. In operation, this pin does the driving; the collet holds the drill in alignment; the collet nut locks the drill in place. The adapter is available for all drill sizes from No. 50 to "F."

The manufacturer states that use of this collet chuck drill adaptor permits a substantial reduction in inventory of twist drills and reduces drill-replacement costs. Zephyr Manufacturing Company, Inglewood, Calif.

A Triumph of Planning

So writes

WALTER DORWIN TEAGUE

noted industrial designer, in describing Bell Aircraft's advances in aircraft production for the war effort today... for *all* tomorrow.

Sealing tubes with the Marsh Metal Tube Seal — a Bell Aircraft innovation now widely used by the aircraft industry.

"I WITNESSED a triumph of planning when I walked through Bell Aircraft's Niagara Frontier Division Plant. I have seen many impressive plants but seldom such perfect order and such high efficiency on so vast a scale.

"It was easy to sense the pride of craftsmanship in the men and women who work there: it became vocal in the machinist who demonstrated his tube-bending machine for me, and the foreman who showed the method he himself had invented for sealing aluminum hydraulic tubes to keep them dust-free.

"And then, from this demonstration of perfected techniques, we went to the laboratories, where scientific knowledge and inventive genius must still work with experimental methods to solve problems that have no precedent. Instead of the calm assurance of the big assembly plant, the atmosphere here in these technological maternity wards was one of barely suppressed excitement: hurry, tension, exhilaration, but above all, confidence.

"This was an event to be remembered, because I saw for the first time two of the most spectacular developments in aviation: I saw the Bell helicopter hover and swing under perfect control within reaching distance of the ground, and I had my first glimpse of a jet propulsion plane. The Bell crowd evidently is as adept at design as it is skilled in manufacturing.

"There are many people I know whom I'd like to take through that plant and those laboratories. They would have a better understanding of what modern industry has grown into now that it's really hitting its stride, and what the future offers in aviation progress for our nation's prosperity."

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MEMBER AIRCRAFT WAR PRODUCTION COUNCIL... EAST COAST, INC.

BELL *Aircraft*

PACEMAKER OF AVIATION PROGRESS

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Buffalo and Niagara Falls, N. Y.
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Airacomet—America's First Jet Propelled Plane
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ORDNANCE DIVISION
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Flexible Gun Mounts and other ordnance materials

GEORGIA DIVISION
Marietta, Ga.
B-29 Boeing Superfortress

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Institute News

Institute Members Inspect Navy Special Devices Section and Patuxent Naval Air Station

On October 6 and 7, a group of members of the Institute made an inspection tour of the Special Devices Division of the Bureau of Aeronautics and the Naval Air Stations at Anacostia and at Patuxent, Maryland.

For reasons of military security, no details of the trip can be published, but members were given the opportunity of inspecting the latest naval developments and seeing some of the more recent naval warplanes and captured enemy equipment.

On Friday evening, October 6, an informal dinner was held in the Hotel Statler in Washington, D.C., for the members and the cooperating naval officers. Dr. J. C. Hunsaker acted as chairman of the dinner and introduced the speakers.

The Honorable Artemus L. Gates, Assistant Secretary of the Navy for Air, spoke about some of his experiences in the South Pacific. Rear Adm. E. M. Pace, Jr., then addressed the members and guests. Capt. Luis de Florez spoke about recent developments in naval training and Capt. Arnold J. Isbell related some of his experiences in the North Atlantic. Other speakers were: W. A. M. Burden, Assistant Secretary of Commerce; L. Welch Pogue, Chairman of the Civil Aeronautics Board; Edward P. Warner, Vice-Chairman of the Civil Aeronautics Board; and T. P. Wright, Civil Aeronautics Administrator.

Major Lester D. Gardner, Chai man of the Council of the Institute, closed the meeting and expressed his appreciation to the Navy Department, the Bureau of Aeronautics, and the cooperating Naval Officers for providing an interesting and informative trip for the members invited.

The members of the Institute who attended the tour were: John D. Akerman, Professor and Head of the Department of Aeronautical Engineering, University of Minnesota; D. F. Bachle, Vice-President, Continental-Aviation and Engineering Cooperation; Leslie A. Baldwin, Vice-President, Johns-Manville Sales Corporation; Rex B. Beisel, General Manager, Chance Vought Aircraft Division, United Aircraft Corporation; Harry E. Blythe, Vice-President and General Manager, Goodyear Aircraft Corporation; George W. Brady, Chief Engineer, Propeller Division Curtiss-Wright Corporation; Clayton J. Brukner, President, The Waco Aircraft Company; Guy L. Bryan, Jr., Chief Designer, The Glenn L. Martin Company; William A. M. Burden, Assistant Secretary of Commerce, Department of Commerce; George W. Burgess, Assistant to Assistant Secretary of Commerce, Department of Commerce; Walter J. Cerny, Design Administrator, Northrop Aircraft, Inc.; M. E. Chandler, Vice-President in Charge of Engineering, Chandler-Evans Corporation; Walter B. Clifford, President and Treasurer, Clifford Manufacturing Company; Charles H. Colvin, Consulting Engineer; Carl DeGanahl, Director of Research, Fleetwings Division, Kaiser Cargo, Inc.; Robert R. Dexter, Secretary, Institute of the Aeronautical Sciences; Hugh L. Dryden, Chief of Mechanics and Sound Division, National Bureau of Standards; James M. Eaton, Vice-President, American Export Airlines, Inc.; Robert E. Ellis, Manager, Aviation Department, Standard Oil Development Company; Allan D. Emil, Director, Square D Company; Andrew J. Fairbanks; Professor of Aeronautical Engineering, Rensselaer Polytechnic Institute; Sherman M. Fairchild, Chairman of the Board, Fairchild Engine and Airplane Corporation; Malcolm P. Ferguson, Vice-President, Bendix Aviation Corporation; George R. Forman, Assistant to the President, Institute of the Aeronautical Sciences; Clifford C. Furnas, Director of Research, Research Laboratory, Curtiss-Wright Corporation; Lester D. Gardner, Chairman of the Council, Institute of the Aeronautical Sciences; R. W. Gemmell, Manager, Westinghouse Electric & Manufacturing Company; B. Allison Gillies, Vice-President, Grumman Aircraft Engineering Corporation; R. E. Gillmor, President, Sperry Gyroscope Company, Inc.; R. T. Goodwin, Manager, Aviation Department, Shell Oil Company, Inc.; Myron Gordon, Vice-President in Charge of Operations, Fairchild Engine and Airplane Corporation; Leroy R. Grumman, President, Grumman Aircraft Engineering Corporation; S. D. Hackley, Vice-President and General Manager, Fleetwings Division, Kaiser Cargo, Inc.; Andrew G. Haley, President, Aerojet Engineering Corporation; R. Paul Harrington, Professor and Head of the Department of Aeronautical Engineering, Polytechnic Institute of Brooklyn; E. H. Heinemann, Chief Engineer, Douglas Aircraft Company, Inc.; A. G. Herreshoff, Chief Engineer of Research, Chrysler Corporation; S. K. Hoffman, Chief Engineer, Lycoming Division, The Aviation Corporation; Bennett H. Horchler, Executive Vice-President, Institute of the Aeronautical Sciences; H. M. Horner, President, United Aircraft Corporation; William S. Hough, Manager, Aircraft Section, Johns-Manville Sales Corporation; Paul E. Hovgaard, Director of Experimental Flight Test, Airplane Division, Curtiss-Wright Corporation; J. C. Hunsaker, Chairman, National Advisory Committee for Aeronautics; Howard L. Jennings, Assistant to the General Manager, Eastern Aircraft Division, General Motors Corporation; Bradley Jones, Professor of Aeronautical Engineering, University of Cincinnati; Roger Wolfe Kahn, Test Pilot and Manager, Service Department, Grumman Aircraft Engineering Corporation; Th. von Kármán, Director of Daniel Guggenheim Aeronautical Laboratory, California Institute of Technology; W. Wallace Kellett, President, Kellett Aircraft Corporation; Otto E. Kirchner, Director of Aircraft Engineering, American Airlines, Inc.; Arnold M. Kuethe, Professor of Aeronautics, University of Michigan; R. H. Lasche, Assistant Vice-President, Director of Engineering and Research, Fairchild Camera and Instrument Corporation; George W. Lewis, Director of Aeronautical Research, National Advisory Committee for Aeronautics; Delbert M. Little, Special Assistant for Technical Services, Weather Bureau, U.S. Department of Commerce; Arthur A. Locke, Professor and Head of the Aeronautical Engineering Department, Wayne University; Grover Loening, Head Consultant, War Production Board; Charles S. Mac Neil, Chief Engineer, Aeroproducts Division, General Motors Corporation; Alfred Marchev, President, Republic Aviation Corporation; Erle Martin, Engineering Manager, Hamilton Standard Propellers Division, United Aircraft Corporation; W. J. McGoldrick, Vice-President in Charge of Aeronautical Engineering, Minneapolis-Honeywell Regulator Company;

Members of the Institute and the United States Navy while on tour in Washington and Patuxent, October 6-7, 1944. (1) W. Wallace Kellett, (2) Alfred Marchev, (3) Paul E. Hovgaard, (4) W. Wilbur Shaw, (5) Comdr. T. B. Clark, (6) Comdr. Paul H. Ramsey, (7) Lester D. Gardner, (8) Capt. A. P. Storrs, (9) William A. M. Burden, (10) George W. Lewis, (11) Carlton Ward, Jr., (12) Th. von Kármán, (13) Arthur A. Locke, (14) Lt. George Bottjer, (15) H. M. Horner, (16) George R. Forman, (17) Allan D. Emil, (18) Howard L. Jennings, (19) W. C. Mentzer, (20) Comdr. R. M. Pray, (21) Charles S. Mac Neil, (22) Comdr. M. W. White, (23) B. R. Otto, (24) Lt. Col. D. E. Cannivan, (25) James S. Pedler, (26) Robert J. Woods, (27) Grover Loening, (28) Col. J. G. Vincent, (29) A. G. Herreshoff, (30) Walter J. Cerny, (31) Philip B. Taylor, (32) Harry E. Blythe, (33) R. H. Prewitt, (34) Bennett H. Horchler, (35) Ralph H. Upson, (36) Roger Wolfe Kahn, (37) Alan Pope, (38) Clifford C. Furnas, (39) R. E. Gillmor, (40) B. Allison Gillies, (41) Arthur T. Newell, (42) Lt. Comdr. Charles R. Wood, (43) William T. Schwendler, (45) Capt. W. G. Switzer, (46) Lt. N. W. Davenport, (47) Robert E. Ellis, (48) Leroy R. Grumman, (49) Capt. J. S. McClure, (50) George B. Wood, Jr., (51) Walter McKay, (52) Conrad F. Nagel, (53) Walter B. Clifford, (54) George W. Burgess, (55) James M. Eaton, (56) Arthur L. Parker, (57) Charles H. Colvin, (58) Rear Admr. G. F. Hussey, Jr., (59) Daniel C. Sayre, (60) James Robinson, (61) Elmer A. Sperry, Jr., (62) Lieutenant Rockefeller, (63) Bradley Jones, (64) Sherman M. Fairchild, (65) Clayton J. Brukner, (66) Myron B. Gordon, (67) Lt. F. A. Smith, Jr., (68) Lt. Comdr. Charles F. Fischer, (69) M. E. Chandler, (70) Lt. Comdr. H. B. Page, (71) Leslie A. Baldwin, (72) William S. Hough, (73) Rex B. Beisel, (75) J. E. Rheim, (76) Roy C. Sylvander, (77) Andrew G. Haley, (78) R. T. Goodwin, (79) John R. Weske, (80) John D. Akerman, (81) Edward P. Warner, (82) Delbert M. Little, (83) R. Paul Harrington, (84) Lt. Comdr. Paul A. Holmberg, (85) Stacy Jones, (86) Carl de Ganahl, (87) S. H. Wilde, (88) Millard E. Bowlus, (89) R. Dixon Speas, (90) Capt. J. A. Callaghan, (91) Otto E. Kirchner, (92) S. K. Hoffman, (93) George W. Brady, (94) E. H. Heinemann, (95) Erle Martin, (96) W. J. McGoldrick, (97) L. E. Root, (98) C. W. Meyers, (99) Allan B. Murray, (100) D. F. Bachle, (101) Lt. Comdr. W. E. Garity, (102) Lt. Comdr. J. C. Clark, Jr., (103) Lt. Jean Mayer, (104) Lt. H. A. Turner, (105) Lt. J. W. King, (106) Lt. W. E. Bates, (107) Capt. T. W. Hobbs, (108) Lt. Comdr. R. J. Teich, (109) Lt. E. J. von Briesen, (112) Comdr. E. J. O'Donnell, (113) George B. Post, (114) Arnold M. Kuethe, (115) William A. Mechesney, (116) Andrew J. Fairbanks, (117) B. J. Vierling, (118) Robert R. Dexter, (119) Hugh L. Dryden, (120) L. Welch Pogue, (121) Guy L. Bryan, (122) Wilbur C. Nelson, (123) Malcolm P. Ferguson, (124) H. A. Sutton, (125) John C. Miller, (126) R. H. Lasche.

Walter McKay, Associate Professor, Massachusetts Institute of Technology; William A. Mechesney, Aviation Manager, Westinghouse Electric & Manufacturing Company; W. C. Mentzer, Chief Engineer, United Air Lines Transport Corporation; C. W. Meyers, Special Representative—Aviation, American, American Steel & Wire Company; John C. Miller, Manager, Aviation Division, General Electric Company; Allan B. Murray, Assistant Director of Experimental Towing Tank, Stevens Institute of Technology; Conrad F. Nagel, Jr., Chief Metallurgist, Aluminum Company of America; Wilbur C. Nelson, Professor and Head of the Aeronautical Engineering Department, Iowa State College; Arthur T. Newell, President and Chief Engineer, Kenyon Instrument Company, Inc.; B. R. Otto, President and General Manager, Otto Aviation Corporation; Arthur L. Parker, President, The Parker-Appliance Company; James S. Pedler, Manager, Aeronautical Division, The B. F. Goodrich Company; L. Welch Pogue, Chairman, Civil Aeronautics Board; Alan Pope, Associate Professor, Aeronautical Department, Georgia School of Technology; George B. Post, Vice-President, Edo Aircraft Corporation; R. H. Prewitt, Vice-President and Chief Engineer, Kellett Aircraft Corporation; J. E. Rheim, Executive Vice-President, Rohr Aircraft Corporation; James Robinson, Assistant Chief Engineer, Vickers Incorporated; L. E. Root, Chief, Aerodynamics Section, Douglas Aircraft Company, Inc.; Daniel C. Sayre, Professor and Chairman, Department of Aeronautical Engineering, Princeton University; William T. Schwendler, Vice-President and Chief Engineer, Grumman Aircraft Engineering Corporation; W. Wilbur Shaw, Director, Sales and Engineering, Firestone Aircraft Company; R. Dixon Speas, Assistant to Vice-President—Engineering, American Airlines, Inc.; Elmer A. Sperry, Jr., Vice-President, Sperry Products, Inc.; H. A. Sutton, Director of Engineering, Consolidated Vultee Aircraft Corporation; Roy C. Sylvander, Chief Engineer, Eclipse-Pioneer Division, Bendix Aviation Corporation; Philip B. Taylor, Vice-President and General Manager, Wright Aeronautical Corporation; Ralph Upson, Consulting Engineer, New York University; B. J. Vierling, Chief Engineer, Pennsylvania Central Air Lines; J. G. Vincent, Executive Engineer, Packard Motor Car Company; J. Carlton Ward, Jr., President, Fairchild Engine and Airplane Corporation; Edward P. Warner, Vice-Chairman, Civil Aeronautics Board; John R. Weske, Professor of Aerodynamics and Head of Aeronautical Engineering Division, Case School of Applied Science; George B. Wood, Jr., Engineer, Special Projects Section, American Bosch Corporation; Robert J. Woods, Chief Design Engineer, Bell Aircraft Corporation; T. P. Wright, Administrator, Civil Aeronautics Administration.

Eighth Wright Brothers Lecture

The Eighth Wright Brothers Lecture, commemorating the forty-first anniversary of the first flights made by Orville and Wilbur Wright at Kittyhawk, N.C., will be held on Sunday afternoon at 3 p.m., December 17, 1944, in the U.S. Chamber of Commerce Auditorium, Washington, D.C.

Mr. John Stack, Chief, Compressibility Research Division, Langley Memorial Aeronautical Laboratory, National Advisory Committee for Aeronautics, has been selected as the Lecturer for 1944. The Lecture will be concerned with compressibility effects on modern high-speed aircraft.

The Lecture will be discussed by leading scientists and engineers.

Col. Donald J. Keirn

Thurman H. Bane Award for 1944

Col. Donald J. Keirn, of the Power Plant Laboratory, Air Technical Service Command, has received the Thurman H. Bane Award for 1944 for "his contribution to the development and utilization of the jet propulsion engine." The members of the Committee making the award were: Honorable Robert A. Lovett, Assistant Secretary of War for Air; Gen. H. H. Arnold, Commanding General, U.S. Army Air Forces; Dr. Lyman J. Briggs, Director, National Bureau of Standards; and Major R. H. Fleet, President of the Institute.

The Thurman H. Bane Award is given annually to an officer or civilian of the Air Technical Service Command for an outstanding achievement in Aeronautical Development. It was established by Major R. H. Fleet in the latter part of 1942. The initial presentation was made to Col. H. F. Gregory for his contribution to the development of the helicopter.

Information on the jet propulsion engine was first made public during the current year. Colonel Keirn was appointed by the Commanding General of the Army Air Forces in 1941 to go to England to analyze the British design, to study the possibility of its adaptation to military aircraft, to return and develop a source of supply, and ultimately to serve as director and consultant to those taking part in the further development of this type of power plant. The work was considered of tremendous importance because of the great promise it holds for future increases in the performance characteristics of aircraft.

In 1943, as a result of intensive effort on the part of Colonel Keirn, together with the excellent cooperation of the General Electric Company and the British Ministry of Aircraft Production, a new jet propulsion engine had been built and was successfully flown.

Colonel Keirn is a native of Colorado and attended Denver schools and the Colorado School of Mines. He is a graduate of the U.S. Military Academy (1929) and Air Corps Engineering School (1937) and holds a master of science degree in Aeronautical Engineering (1938) from the University of Michigan. He has been stationed at Wright Field since 1936.

Late J. B. Taylor, Jr., Awarded Navy Distinguished Flying Cross

The Navy Department recently made a posthumous award of the Distinguished Flying Cross to the late Lt. Comdr. James Blackstone Taylor, Jr., U.S. Naval Reserve, of New York City, who lost his life on May 25, 1942, when flight-testing a Navy fighter plane.

Lieutenant Commander Taylor was an Associate Fellow of the Institute and of The Royal Aeronautical Society, Great Britain; a founder of the Aviation Country Club of Hicksville, Long Island; and a member of the American Society of Mechanical Engineers and many other organizations. He will long be remembered for the outstanding contribution he made to civil and naval aviation. He is credited with having tested over 500 different types of aircraft during the period from 1920 to

Lt. Comdr. James B. Taylor

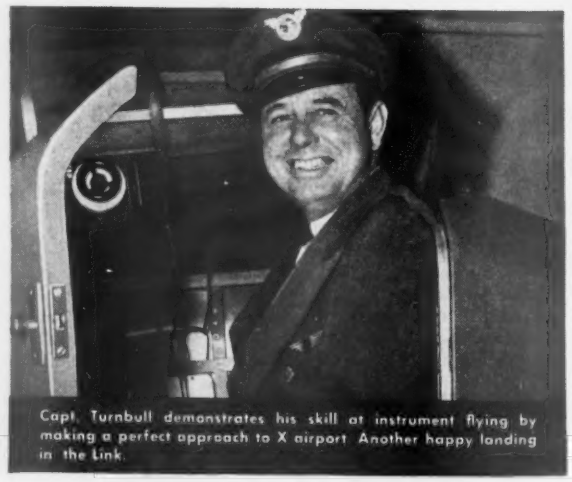
Meet CAPT. VIRGIL TURNBULL

Two-million-mile veteran Braniff pilot Capt. Virgil Turnbull stands for the kind of flying that has won for Braniff the National Safety Award for four successive years. Born in McClain Co., Okla., Turnbull began flying in 1922. After several years' "barnstorming," he became a transport pilot in 1929; joined Braniff in 1936.

Capt. Turnbull is "briefed" for Link Trainer refresher course problem by Chief Pilot R. V. Carleton and Director of Instrument Flying Claude Seaton.

Turnbull gets ready to "take off" in the Link. His problem is to approach X airport on instruments, guided by radio signals

Mrs. Betty Nance, Braniff Link Instructor, gives Capt. Turnbull the weather and other conditions of the flight through the interphone.



Capt. Turnbull demonstrates his skill at instrument flying by making a perfect approach to X airport. Another happy landing in the Link.

LINK is known in Aviation for creative engineering and high standards of manufacture. Look for the name LINK on precision products after the war.

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Link Aviation Devices, Inc.

Binghamton, New York, U. S. A.

LINK MANUFACTURING COMPANY, LTD., Gananoque, Ontario, Canada

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his death. (The necrology was published in the July, 1942, issue of the AERONAUTICAL ENGINEERING REVIEW).

The citation reads as follows: "For heroism and extraordinary achievement in aerial flight as a test pilot engaged in experimental flight attendant upon the development of new types of aircraft during a prolonged period of aviation progress. Volunteering to carry out extremely hazardous demonstration flights of military planes requiring terminal velocity dives, high accelerations, spins and acrobatics, Lieutenant Commander Taylor frequently risked his life in the most unconventional types of aircraft, many of which had never previously been tested in these vital maneuvers. While testing a new plane for the Navy at Dahlgren, Maryland, in March, 1939, he lost consciousness as a result of severe acceleration during the violent pull-out after a high-speed dive but, with part of his craft torn loose and a wing deformed, brought the plane under control immediately upon regaining consciousness and successfully flew into the airport. On May 25, 1942, although fully aware of the peril involved, he volunteered for an exceptionally dangerous flight to test a new Navy fighter plane and lost his life when the electrical control mechanism failed to function. Lieutenant Commander Taylor's superb airmanship, great personal valor, and fearless devotion to duty were responsible in large measure for the rapid advance of military aviation and in keeping with the highest traditions of the United States Naval Service."

Gifts to the Aeronautical Archives

Dr. Orville Wright gave the drawing instruments of Octave Chanute, in the original box with Chanute's metal name plate. The instruments were transmitted to Dr. Wright in 1928 by William Spencer Crosby, architect engineer of Chicago, Ill., who came into possession of them at the death of his partner, J. K. Cady, a friend of Octave Chanute.

Capt. Walter S. Diehl, U.S. Navy, sent 228 issues of aeronautical periodicals, from the estate of Victor Lougheed. *Aero Digest*, through the courtesy of Frank S. Tichenor, sent 260 issues of periodicals. The Eclipse-Pioneer Division of the Bendix Aviation Corporation gave 125 issues of periodicals, adding to its previous gifts.

Dr. Mac Kronstein presented a bound manuscript check list of his aero-philatelic researches and publications. Seven books were received on exchange from the Library of Congress, including the *Almanach des Muses* for 1782 through 1785, and W. K. Vanderbilt's *Flying Lanes*, New York, 1937. A copy of the *Supplement to a Bibliography of Aviation Medicine*, Washington, 1944, was received from Dr. John Farquhar Fulton, of the Yale Medical Library. The British Air Commission added 52 *British Air Ministry Translations* to the large number previously given. *The 1944 Marine Catalog and Buyers' Directory* was received from the Simmons-Boardman Publishing Corporation through the courtesy of Warner Lumbard.

A print of the B-29 Boeing Superfortress bomber was sent by Thomas F. Collison. The Georgia Division of the Bell Aircraft Corporation gave a complete file of its *Bell Aviation News*. A complete file of the *Bell Ordnance News* was received from the Ordnance Division of Bell Aircraft Corporation.

Lt. George A. Hughes gave a German wing insigne. A lapel pin of the Spier Aircraft Corporation was sent by I. Martin Spier. Four insignia and six uniform buttons of the British Overseas Airways Corporation were given by that company through the courtesy of Paul E. Bewshea. Major K. M. Beaumont sent a copy of the *First Report of an Independent Committee on Civil Aviation*, London, 1943.

Additional gifts were received from Evans Products Company; Lincoln Electric Company; Physicists Research Company; Nicolas Sanabria, Inc.; Society of Automotive Engineers; the U.S. House Document Room; Office of the Air Surgeon of the Army Air Forces; U.S. Armed Forces Institute; Army Service Forces; Recruiting Publicity Bureau of the U.S. Army; Civil Aeronautics Administration; Bureau of Foreign and Domestic Commerce; Departments of the Interior, Labor, State, and Treasury; National Archives; Superintendent of Documents; Bureau of Public Relations of the War Department; Congressional committees on appropriations; and the Vermont Motor Vehicle Department, Aviation Section.

New Corporate Members

The following are brief summaries of the products and activities of companies that have recently become Corporate Members of the Institute.

The Clifford Manufacturing Company, Boston, manufactures hydraulically formed metallic bellows and bellows assemblies, extruded aluminum tubes, and all-aluminum oil coolers and coolant radiators.

During the present war practically its entire bellows-production facilities have been converted to the production of bellows units for aeronautical use, among which are the following: supercharger controls, bombsight servo mechanisms, automatic pilots, oxygen regulators, hydraulic remote control of gasoline tanks, thermostats for control of coolant radiators and oil coolers, manifold pressure gauges, altimeters, airspeed indicators, rate-of-climb indicators, and cabin pressure and temperature controls.

The company has developed, and is believed to be among the first to achieve, quantity production of aircraft-engine oil coolers and coolant radiators that are made of heat-treatable aluminum alloy. The feature of this development is the weight-saving, which is reported to be two-thirds of the weight of equivalent heat exchangers made of other metals.

General Aircraft Equipment, Inc., South Norwalk, Conn., has been engaged in aeronautical activities since its creation in May, 1941. It has manufactured major airplane parts, particularly parts going into the power-plant section of fighters, bombers, and transport airplanes.

Walter Kidde & Company, Inc., New York, manufacturers of fire-protection equipment for airplanes, are also serving the aircraft industry in many other ways. Through greatly increased plant facilities, high-speed machines, and work simplification programs, the company has increased the output of fire-detection and extinguishing systems and has developed new compressed-gas safety devices. Among the new products developed and placed in production are the lightweight shatterproof oxygen and carbon-dioxide cylinders; oxygen recharging pumps for use at advanced field bases where water and power lines are not available; inflation cylinders for parachute, drop, and pack rafts; and a water-sensitive device for automatically expelling and inflating a raft stored in special compartments of carrier-based planes.

Further developments in the compressed-gas field include packaged power in the form of special high-pressure cylinders used for emergency power actuating devices—such as landing-gear controls, bomb bay doors, and brakes—for use when hydraulic systems have been disabled; a carbon-dioxide flooding system for explosion-proofing wing and fuselage spaces around gasoline tanks; and a vapor dilution system for purging auxiliary gas tanks. This company was widely known for the development of new devices in the fire-protection and fire-extinguishing field, such as the built-in fire-extinguishing systems for protecting airplane-engine and auxiliary spaces; lightweight portable carbon-dioxide fire extinguishers for cabin spaces; and flame- or smoke-detecting devices for engine or cargo spaces. A number of automatic signaling or actuating devices to warn pilots of a fire or to set off automatically a plane's fire-extinguishing system in the event of a crash have also been developed.

Inflation equipment ranges from small carbon-dioxide bullets for inflating life belts and life vests to the larger cylinders containing sufficient quantities of carbon dioxide for inflating rubber life rafts of all sizes and flotation bags large enough to support an entire plane. Other types of equipment of interest to the aircraft industry are the carbon-dioxide mobile crash trucks used for fighting fires at flying fields and air bases.

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WILL HELP YOU DO IT IN 1945

Sustained post-war employment means large volume production of better products at reasonable prices . . . that's the story.

● Many component parts of your post-war products can be made better, faster, cheaper—with OH-38.

OH-38 Aluminum Alloy—Non-Heat Treated—an exclusive product of Hedstrom—is a perfected metal with proven superiority in a wide range of machining operations.

Easily machinable—easy on tools—increases tooling accuracy—holds threads without stripping. Non-corrosive—non-oxidizing—non-magnetic—spark-proof—does not require heat treatment—will not expand or contract. Tensile strength: 35,000 to 40,000 lbs. per square inch. Polishes to silver mirror brilliancy—takes chrome, nickel, or tin plating—may be annodized. Has many other manufacturing advantages.

OH-38 is used only in castings by Hedstrom. Our Pattern Service will supply complete models of parts for your new products. Send for technical information.

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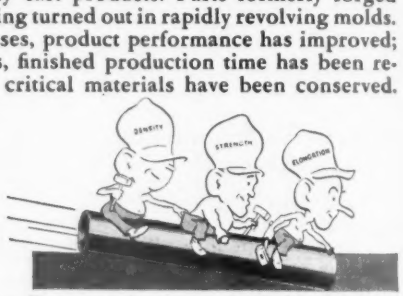
Manufacturers of Aluminum, Brass, Bronze and High Conductivity Copper Castings. Pattern Makers. Complete Mechanical Assemblies and Models to Specifications

New Uses for SHENANGO-PENN Centrifugal Castings

WARTIME production demands have led aviation engineers to a greater reliance upon centrifugally cast products. Parts formerly forged are now being turned out in rapidly revolving molds. In many cases, product performance has improved; in all cases, finished production time has been reduced and critical materials have been conserved.



Shenango-Penn castings can probably be used wherever wheels turn or where wearing or corrosion exist. Because the process is so flexible, it is possible to furnish flanges and to work out unusual shapes and sizes. Our standard alloys meet all Army, Navy and Air Corps specifications—and are constantly tested and checked in our own laboratory.

Why not call on our metallurgical and engineering experience to determine whether there are new uses possible in your production?

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SHENANGO - PENN

Liberty Aircraft Products Corporation, Farmingdale, L.I., N.Y., was organized in 1932 for the manufacture of aircraft parts. It has been continuously engaged in this production since that time for such companies as the Grumman Aircraft Engineering Corporation; Airplane Division, Curtiss-Wright Corporation; Republic Aviation Corporation; Edo Aircraft Corporation; General Motors Corporation; Columbia Aircraft Corporation; and The Glenn L. Martin Company.

The parts consist of wings, ailerons, rudders, elevators, stabilizers, fins, floats, and other sheet-metal parts, with complete service for press work, covering, doping, and finishing. It also makes all types of parts requiring machining, sandblasting, heat-treating, anodizing, metallizing, and cadmium and hard chromium plating. Much of this is precision work and includes the manufacture of gear-box mechanisms for operating retractable landing gears, hydraulic mechanisms, and fittings of all types.

The Liquidometer Corporation, Long Island City, N.Y., manufactures instruments for the purpose of gauging the quantity of fuel, oil, de-icer fluid, windshield alcohol, hydraulic fluid, or other liquids contained in tanks on aircraft. These instruments are designed and constructed in accordance with joint Army-Navy specifications and are extensively used on Army, Navy, and commercial airplanes. Remote indication, which is necessary on most types of aircraft, is provided by either an electrical or a hydraulic transmission system. Non-remote-reading (direct) types are available where indication directly at the tank is feasible.

Many types of indicators are available, the selection of which depends on the number of tanks in the airplane, space availability, and tank capacities. Where desired, sealed low-level warning switches can be included in transmitter units, or an especially designed switch can be provided to control the liquid in the tank between predetermined levels. Gauge systems are also manufactured whereby a single indicator indicates the total amount of fuel or other liquid contained in a group of tanks.

Liquidometer instruments are made also for the purpose of indicating propeller pitch and the position of flaps, wheels, or other devices.

Titeflex, Inc., Newark, N.J., serves the aviation industry as one of the leading manufacturers of radio-shielded ignition harnesses for aircraft engines. Original applications of Titeflex products were for fuel and oil lines on aircraft engines as far back as World War I. With the increased use of radio in aircraft, flexible metallic tubing found a new use as shielding conduit for aircraft ignition systems.

Much research and development work in providing interference-free radio communication has been done by the company. Planes equipped with Titeflex ignition harnesses were flying in 1934, and since then the company has continuously improved its products to keep pace with the increased use of radio and electronic devices on American planes.

During the present war the company has had to expand its facilities greatly in order to supply ignition shielding harnesses in the quantity required. Assemblies are supplied for Pratt & Whitney, Wright, Jacobs, Continental, and Ranger engines.

Two recent major developments have been the "Unimold" ignition lead for high-altitude planes and "Aerocon" conduit for use as a high- and low-tension shielding conduit.

Vickers, Incorporated, Detroit, is one of the oldest and largest manufacturers of oil-hydraulic power-transmission devices in this country. Incorporated in California in 1922 to meet urgent demand for gear-type hydraulic pumps for repair and replacement of earth-moving machinery, the company expanded its activities to include the production of vane and piston pumps, as well as valves, for hydraulically operated machine tools and presses.

The company moved to Detroit in 1929 in order to be near the center of the machine tool and automotive industry. Constant research in an effort to develop new markets for hydraulic power transmissions led to the development of highly specialized equipment for the U.S. Navy. The next step in keeping with the times resulted in production of power hydraulic devices for aircraft.

In 1939 several problems, including hydraulics, were undertaken in cooperation with two of the larger aircraft manufacturers. Probably the most noteworthy outcome of this growth was the development of a successful piston-type engine-driven hydraulic pump, which in less than 5 years has become widely used on American aircraft. The latest version of this is being used to develop pressure of 3,000 lbs. per sq.in. for the hydraulic systems of production airplanes.

The design of power-operated turrets brought to the industry an entirely new set of problems involving accurate control of variable speeds, reversibility, and high starting torque. The piston-type pump and motor combination of variable-speed transmission soon proved to be the means of solving these problems.

Vidal Research Corporation, Camden, N.J., designs, constructs, and tests prototype air-frame and aircraft parts, using its own developed processes for the fluid pressurizing of plastic-treated materials. The processes, along with the necessary engineering service, are provided licensee firms in both the United States and foreign countries. Currently, some ten domestic and three foreign firms are employing the Vidal processes and engineering services.

Since building the first all-molded airplane in the United States in 1938, a great variety of aircraft structures and parts have been designed, developed, and tested by the company. These articles include wings, fuselage, and tail assemblies for private, trainer, bomber, pursuit, and cargo aircraft.

Recent deliveries include helicopter bodies of a new molded "sandwich" material and airplane-wing structures of the hollow corrugated-spacer, double-surface type. Recent load and other tests indicate that the new combinations of metal or other high-strength materials with cores of veneer and even lighter materials, because of their rigidity without stiffeners, may replace certain air-frame metal designs.

Articles other than air-frame structures produced by Vidal licensees include Fiberglas radar domes, paper corrugated floor boards, plywood tubing, laminated fabric wing tips, and many similar products.

Corporate Member Changes Name

The name of Aircraft Industries Company, Glendale, Calif., a corporate member of the Institute, has been changed to Grand Central Airport Company. The change follows the purchase of Grand Central Air Terminal by the company, and no change other than name is involved. Also, Curtiss-Wright Technical Institute, school of aeronautical engineering and aviation mechanics which the concern operates, has been renamed Cal-Aero Technical Institute.

Sections and Branches

Buffalo Section

The first technical meeting of the 1944–1945 session of the Buffalo Section was held at the Hotel Westbrook on July 25. The following committee appointments were announced by the Chairman: Membership Committee: Chairman, E. J. Pelletier; G. C. White, H. Nagamatsu; Meetings and Paper Committee: Chairman, P. E. Hovgaard; S. B. Elggren, R. Poole, F. W. Ocvirk, A. Krivetsky, C. Fay; Nominating Committee: Chairman, F. R. Weymouth; J. Robinson, H. Dotts, R. K. Koegler, J. S. Limage; Special Committee on Constitution: Chairman, V. J. Norris; R. J. Sandstrom, E. E. Foster.

The respective chairmen of the committees reported on committee activities. These included introductions of new members by the Membership Committee, the change in the meeting dates to Tuesdays, and a report by the Constitution Committee concerning revi-

I. A. S.

National Meetings Schedule

1944–1945

December 17, 1944
WRIGHT BROTHERS LECTURE — WASHINGTON, D.C.

January 30–31, February 1, 1945
THIRTEENTH ANNUAL MEETING — NEW YORK

April 26–27, 1945
SPRING MEETING — DETROIT, MICHIGAN

May 16–19, 1945
JOINT MEETING WITH THE SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS — BUFFALO, N.Y.

July, 1945
ANNUAL SUMMER MEETING — LOS ANGELES, CALIF.

October, 1945
AIR TRANSPORT MEETING — WASHINGTON, D.C.

The Officers and Council of the Institute invite participation in the Technical Sessions of the Meetings of the Institute.

The Meetings Committee will consider for inclusion on the program complete papers, or outlines or summaries of proposed papers.

Information for Participants

(1) Complete papers, or outlines or summaries should be submitted in triplicate at least four months prior to the meeting at which it is proposed to present the paper. Outlines or summaries should not exceed 1,000 words.

(2) Each paper should be so planned that it may be presented within a time limit of 45 minutes.

(3) All papers submitted will be considered for publication in the **Journal of the Aeronautical Sciences** or the **Aeronautical Engineering Review.** While a paper should be planned to take only 45 minutes for presentation at a meeting, the written presentation may have a maximum length of approximately 15,000 words.

(4) All material received will be submitted to the Meetings Committee. Authors will be notified, in ample time to prepare the complete paper, whether or not their papers can be scheduled for presentation.

All correspondence should be addressed to

The Meetings Committee
Institute of the Aeronautical Sciences
1505 RCA Building West
30 Rockefeller Plaza
New York 20, N. Y.

sions of the constitution and the reading of portions of the constitution that are of major interest. The Treasurer's report also was given.

Dr. Cartledge, of the Curtiss-Wright Research Laboratory, was introduced by Mr. Krivetsky and gave a lecture on "Vapor Lock in Aircraft Fuel Systems." The lecture was supplemented by motion pictures and slides showing the experimental investigations conducted at the Laboratory and in conjunction with actual flight-test investigations.

Dr. Hawkins introduced George Ray, of Bell Aircraft Corporation, who gave an account of the "Trend in the Development of Russian Fighter Type Aircraft." The speaker compared United States and Russian fighter-airplane designs, indicating the points of difference and similarity. The lectures were followed by discussions.

The second technical meeting of the current season was held on September 19, with 73 members and guests present. Following the custom established at the first meeting, the guests were introduced by their respective hosts. The first speaker was George McConnell, of the Curtiss-Wright Service Department, who discussed the problems that confront service men in the various fields of battle, such as Africa, Australia, and New Guinea. He related many problems that were solved in the field but that were considered impossible from an engineering standpoint. He called attention to the fact that airplanes in military service often have to do work for which they were not initially designed. He emphasized the need for close cooperation between the engineering department and the service men in the field.

The second speaker was Benson Hamlin, of Bell Aircraft Corporation. He discussed the theory of jet propulsion and related humorous incidents that occurred in his experience of flight testing jet-propelled aircraft. Discussions followed each lecture.

Texas Section

The first meeting of the new Texas Section was held September 29 at the Blackstone Hotel in Fort Worth, Tex.

The constitution and by-laws were read and the following officers were elected: Chairman, Oscar N. Thompson; Vice-Chairman, Horace E. Burrier; Secretary, Lawrence E. Heyduck, Jr.; Treasurer, Bruce Mitchell; Executive Committee, M. R. Schoenfield, J. Osborn Johnson, Ralph D. Baker, and Milton J. Thompson.

The meeting was concluded with a lecture by Dr. Thompson on the "Analysis of the Aerodynamic-Drag Spectrum."

Los Angeles Section

A meeting of the Los Angeles Section on September 22 was held under the chairmanship of A. E. Raymond. Plans for a local section building were discussed, after which the Chairman

THE FIRST VICTORY WAS OVER *Dead Weight*

Low in alloy content—high in the physical characteristics that make steel great—N-A-X alloy steel has helped to give America tougher, deadlier weapons of war. It has taken its place in fighting equipment of all types—in planes, tanks, landing craft, mobile artillery, gun carriages, combat vehicles and scores of other applications where *weight could be reduced and performance improved* by the strength, impact resistance and long fatigue life of N-A-X alloy steel.

N-A-X alloy steel is produced in *high-tensile* grades and in *carburizing* and *constructional* grades to give industry a great all-purpose steel of virtually constant analysis. Stronger and tougher than mild carbon steel, N-A-X alloy steel retains the advantages of excellent response to heat treatment, machinability, easy cold forming and weldability. More economical than commercial high-alloy steel, N-A-X alloy steel compares favorably in tensile strength, yield strength, elongation, reduction of area and Izod notched bar values.

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N-A-X 9100 SERIES steel is produced in both molybdenum-bearing and molybdenum-free types. Series X-9100 type, containing molybdenum, provides extra-deep hardenability.

N-A-X ARMORPLATE, used in tanks, armored cars and practically every landing craft built today, is an example of the versatility of Great Lakes low-alloy steel. The exacting requirements of this application, calling for extreme toughness, hardness and impact resistance, have been met consistently by this N-A-X alloy steel.

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AS designers and builders of special machinery, special tools, and special parts FENN brings you the accumulated experience of *three generations* continuously engaged in precision machine shop work.

FENN will handle the entire job from blue prints straight through to the finished machine, tool, or part; or take your idea, develop it, and build a machine that will do what you expect of it.

FENN'S long experience on the shop floor and their knowledge gained in solving many difficult mechanical problems give them an individual approach to every problem. For FENN definitely expects to add that something to the finished machine that will pay dividends in faster, smoother, more dependable operation.

IT costs nothing to consult with FENN and no obligation is incurred until you are certain that they can contribute tangible, measurable value to your machinery problems. Your inquiries will have careful and prompt attention.

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introduced C. L. Johnson who in turn introduced W. R. Sears. Irving L. Ashkenas, of Northrop Aircraft, Inc., gave a talk on a subject of "The Development of a Lateral Control System for Use with Large Span Flaps." Prepared discussions were given by George Worley and Leon Stuhlman, followed by comments by M. R. Stanley, a Northrop test pilot. Informal discussion closed the meeting.

New York Section

A meeting of the New York Section of the Institute was held on Friday, October 13, at 8 p.m., in the auditorium of the McGraw-Hill Building in New York.

The subject of the meeting was power control. Colin H. McIntosh, Chief Navigator of the Flight Operations Department of American Airlines, Inc., spoke about cruise control. Fifty members and guests attended the meeting.

Illinois Institute of Technology

At a meeting on October 4 an open discussion was held concerning future classes desired in the aeronautical engineering curriculum at the Illinois Institute of Technology, and a committee composed of Messrs. Goetsch, Spooner, Mayster, and Eller was appointed to make a further study of the matter.

Edward Goetsch was appointed temporary chairman to serve until the next election.

Iowa State University

At a meeting of the Branch on September 20, Prof. W. C. Nelson gave a talk on "Wright Field Developments" in which he told about the work being done by the Air Technical Service Command at Wright Field, some of the recent advancements made there in the field of aeronautics, and the facilities available there.

John Yardley, Senior Engineering Council Representative, gave a report on the Engineering Council meeting.

Casey Jones School of Aeronautics

The following were recently elected officers of the Casey Jones School of Aeronautics Branch: Chairman, Warren Reider; Vice-Chairman, George Grabowski; Secretary, Calvin Leinwand; Treasurer, John O'Brien; Sergeant-at-Arms, Arthur Sanders; Corresponding Secretary, Paul Nenninger.

University of Oklahoma

At a meeting on September 11 the University of Oklahoma Branch was reactivated and the following officers were elected: Chairman, C. R. Howard; Vice-Chairman, G. W. Hughes; Secretary-Treasurer, D. D. Engle.

Plans were made for presenting an exhibit at the annual Engineer's Open House gathering. Preceding the meeting two films were shown, one depicting the history of flight and the other showing the care and use of the parachute. During the running of the films, Fred Mouck, of the Mechanical Engineering Department, gave comments on the material presented.

Polytechnic Institute of Brooklyn

The first meeting of the present semester was held on July 31. Prof. N. J. Hoff, of the faculty of the Polytechnic Institute, gave a talk on glider development based on his personal experiences. He traced the growth of gliding from the years closely following the first World War, detailing his first flight and giving hints for future pilots. He indicated the type of terrain that is favorable to gliding and the requirements for gliding and soaring flight.

At the second meeting on August 31 Bertram Klein, Research Assistant in the Polytechnic Aeronautical Structures Laboratory, spoke on "Time as Related to Astronomy." He emphasized the means of correcting time pieces by astronomical methods.

The third meeting held on September 7 was addressed by Ben Shupack, Secretary of the American Soaring Society, who showed a film and slides about soaring. Mr. Shupack gave a narrative discussion in connection with the pictures.

The final meeting of the semester on September 12 was the second joint meeting with the student branch of the American Society of Civil Engineers. At this meeting Clint A. Schofield, Project Engineer of American Airlines, Inc., gave a talk on "Engineering Problems in Future Airport Planning." He discussed a recently proposed method of tangent runways and presented slides showing the difficulties in such planning and how the problems will be solved.

University of Texas

At the regular September meeting of the University of Texas Branch, Dr. B. E. Short and his ME 443 class were guests of the Branch. The Wright Aeronautical Corporation's motion-picture film *Cyclone Combustion*, showing and explaining the operation of the Wright Cyclone engine, was shown.

Vacancies among the officers were filled by the election of Merle Mueller as Treasurer and Lonnie Rice as Recording Secretary.

Tri-State College

The Fall term of Tri-State College Branch was opened by a meeting at which the following officers were elected: Chairman, Gordon Fries; Vice-Chairman, Jack Hoyt; Secretary-Treasurer, Charles Dusheck.

News of Members

Ralph D. Baker has joined Consolidated Vultee Aircraft Corporation as an Aerodynamicist.

Millard V. Barton has been on leave of absence as Professor of Aeronautical Engineering at the University of Texas to participate in a cooperative program with Douglas Aircraft Company, Inc., in structures, vibration, and flutter analysis.

Henry Berman has joined Gassner Aircraft Engineering Corporation as a Junior Stress Analyst.

Hugh Boyd received his commission as an Ensign in the U.S. Naval Reserve.

Woodward Burke is now Director of Flight Research at McDonnell Aircraft Corporation.

V. Cadambe is now a Stress Analyst, Class "A", in the Engineering Department of Douglas Aircraft Company, Inc.

Jack M. Cherne has become a member of the Structural Research Department at the Langley Memorial Aeronautical Laboratory of the N.A.C.A.

George Cladis has become connected with the Sikorsky Aircraft Division of the United Aircraft Corporation as a Layout Draftsman.

Martyn V. Clarke is now a Stress Analyst with Republic Aviation Corporation.

Lt. Millford E. Collins has been transferred to the Corpus Christi Naval Air Station as Chief Engineer of the Assembly and Repair Department.

Herbert A. DeCenzo has rejoined Northrop Aircraft, Inc., as Aerodynamicist, Class A, in the Research Department.

Charles H. Dolan, formerly President of Empire Research Corporation, has been elected Vice-President and General Manager of Allied Engineering Corporation.

Charles E. Farrell has joined Goodyear Aircraft Corporation as Foreman of Production Control.

Delbert J. Forward is now Project Engineer with the American Propeller Corporation.

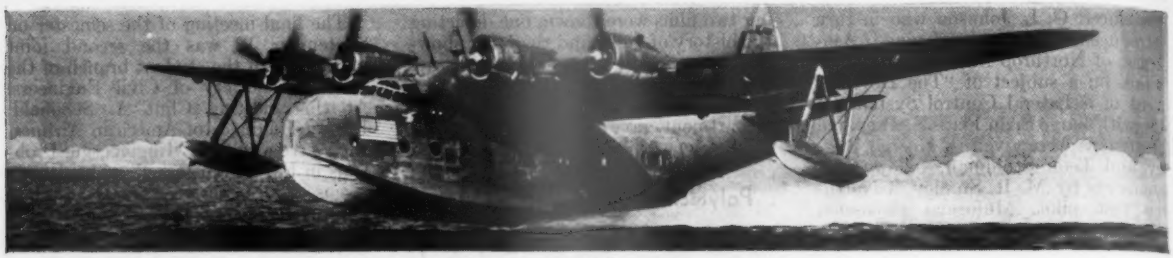
Reginald E. Gillmor, President of Sperry Gyroscope Company, Inc., has been elected to the additional office of Vice-President of the Sperry Corporation, the parent organization. He will continue to head the Sperry Gyroscope Company, Inc.

Myron B. Gordon, formerly Vice-President and Director of Curtiss-Wright Corporation and Vice-President, General Manager, and Director of Wright Aeronautical Corporation, has been elected a Director of Fairchild Engine and Airplane Corporation and Vice-President in Charge of operations.

Raymond D. MacCart, a retired Commander in the U.S. Navy and formerly Assistant Chief Division Engineer of Consolidated Vultee Aircraft Corporation, has been elected President of the Brown Brothers Foundry, Inc.

Louis F. Monts has become connected with the Fort Worth Division of Consolidated Vultee Aircraft Corporation.

John T. Newark has been appointed a Staff Engineer with Engineering Enterprises.



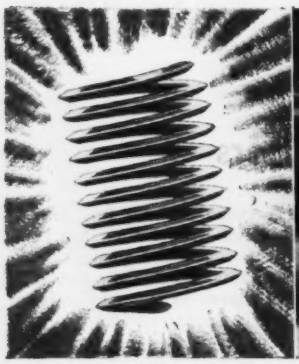
HOW "Heli-Coil" INSERTS REDUCE HOURS TO MINUTES

In the shops of American Export Airlines, Inc., replacement of burned or worn-out spark plug bushings formerly required removal of the cylinder from the engine. This took several hours—often most of a day. Today, "Heli-Coil" Inserts restore the bushings to perfect condition in less than an hour—*without removing the cylinder*. They are easily installed—using only simple hand tools in maintenance operations (see photographs below).

"Heli-Coil" inserts are also used in original installations as spark plug and stud bushings, providing a tight wear-resistant, leak-proof fitting. They will not corrode in storage or service, and in the case of spark plugs, eliminate freezing and insulation, permitting removal of spark plug with same torque as used for installation. For assembly on a production basis, power tools are available.

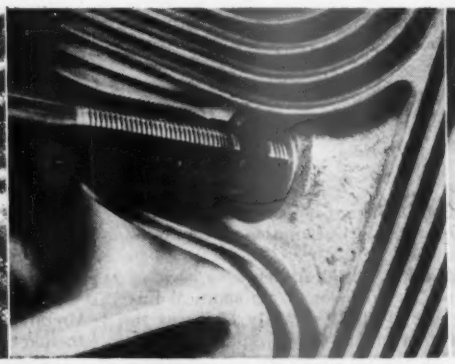
"Heli-Coil" Inserts are precision-shaped stainless steel helical coil thread-liners. They engage the retapped thread of the spark plug bushing, or any American National tapped thread providing a permanent, hard, smooth surface. They are about one-fifth the weight of solid bushings and occupy less than half as much cross sectional area, permitting more latitude in design and greater strength. Send for further information.

THE SCREW SYSTEM WITH THE ANTI-FRICTION THREAD LINING



U. S. and Foreign Patents Issued and Pending

INSERTING tool is placed over the tapped hole and Insert wound through threaded sleeve into hole.



REAMING out old thread and tapping new thread for the "Heli-Coil" Insert, in one operation in shops of American Export Airlines, Inc.

EXPANDING tool ready to be screwed into Insert. Mandrel will then be pushed down into sleeve, forcing Insert into walls of tapped hole.

CLOSE-UP of inserting tool, comprising mandrel and threaded sleeve, with Insert in sleeve.

STAKING sleeve is placed over expanding mandrel until sleeve meets boss. Light blow on top of sleeve knurls chamfered edge around hole, locking Insert into walls of tapped hole.

HELI COIL

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Eli S. Newberger received his commission as an Ensign in the U.S. Naval Reserve.

Parameswar Nilakantan has returned to Indian Institute of Science at Bangalore City, India, as Lecturer in Aeronautics.

John W. Pocock has joined Booz, Allen & Hamilton as Senior Staff Engineer.

Ernest R. Reff is now a Project Structure Engineer with Republic Aviation Corporation.

Edward L. Semones has transferred to Spartan Aircraft Company as a Stress Analyst.

Ralph H. Sogard is now an Experimental Flight Engineer at Boeing Aircraft Company.

Warren A. Stauffer has received his commission as an Ensign in the U.S. Navy.

Mann C. Sweet has become connected with Southern Airways, Inc., as an Engines Instructor.

Members Elected

The following applicants for membership or applicants for change of previous grade have been admitted to membership in the grades indicated since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Ward, Kenneth Edwards, B.S. in M.E.; Design Specialist, Aerodynamics, Consolidated Vultee Aircraft Corp.

Elected to MEMBER Grade

Borg, Milton Harold, Lt., U.S. Army Air Forces.

Calamai, Edward Albert, Capt., Squadron Engineering Officer & Squadron Technical Inspector, U.S. Army Air Forces.

Crowley, Donald Martin, B.Ae.E.; Meteorologist, Transcontinental & Western Air, Inc.

Davidson, Howard Calhoun, B.S.; Major General, U.S. Army Air Forces.

Heath, William Clarence, Chief Engineer, Solar Aircraft Co.

Henning, Harold Paul, Licensed Pilot, Chevrolet Motor Div., General Motors Corp.

Kenyon, Willis Elbert, B.S. in M.E.; Assoc. Mechanical Engineer, Aircraft Engine Research Lab., N.A.C.A.

Leonard, Lloyd Hugo, B.S. in M.E.; Chief Engineer, Zimmer-Thomson Corp.

Macina, Conrad, Dr. in C.E.; Chief Stress Analyst, Pratt, Read & Co.

MacPhail, Donald Campbell, Ph.D.; Scientific Officer, Ministry of Aircraft production (England).

Nelles, Maurice, Dr., A.M.; Staff Asst. to Director of Research, Lockheed Aircraft Corp.

Ready, John Thomas, Jr., Asst. Chief Flight Test Engineer & Test Pilot, Consolidated Vultee Aircraft Corp.

Reid, John Philipp Milford, B.S. in M.E. & E.E.; Air Engineer & Test Pilot, British Air Commission.

Tabatchnik, Joshua, M.Sc. in C.E.; Sr. Airplane Stress Analyst, Otis Elevator Co.

Transferred to MEMBER Grade

De Cenzo, Herbert Alexander, B.Ae.E.; Aerodynamicist, Northrop Aircraft, Inc.

Haskins, Robert, Jr., M.S.; Private, U.S. Army Air Forces.

Pagon, Garrett Dunn, A.B. in Engineering, Chief of Structures, Edward G. Budd Mfg. Co.

Schnaubelt, Franz Joseph, Design Engineer, San Diego Div., Consolidated Vultee Aircraft Corp.

Weill, Melville Kaiser, B.S. in M.E.; Pres. & Treas. Skydyne, Inc.

Elected to Industrial Member Grade

Geuting, Joseph Thomas, Jr., Vice-Pres. & Director, General Aircraft Corp.

O'Neill, Stephen Joseph, Asst. to Director of Training, American Export Airlines, Inc.

Williams, Henry Lionel, Academy of Aeronautics.

Elected to Technical Member Grade

Agin, James Lester, Engineering Aide, Wright Field, War Dept.

Beverage, Arthur Walter, Jr., B.S. in C.E.; Weight Officer, Curtiss-Wright Corp.

Crawford, Robert, Flight Officer, U.S. Army Air Forces.

Demming, Gerald Arthur, Sr. Functional Test Pilot, Bell Aircraft Corp.

Johnson, Rudolph Albert, Corp., U.S. Army Air Forces.

Key, Cleo Hubert, B.S. in M.E.; Engineer, Sperry Gyroscope Co., Inc.

Kivinen, Arthur Hannes, Analyst, The De Havilland Aircraft of Canada, Ltd.

Lagerstrom, Paco Axel, Ph.D.; Research Engineer, Aerodynamics Dept., Bell Aircraft Corp.

Meister, Arthur, Aeronautical Layoutman, Pratt, Read & Co.

Neustein, Joseph, B.S. in M.E.; Research Engineer, Aircraft Engine Research Lab., N.A.C.A.

Nichols, George Edmund, B.S. in Ae.E.; Structures Research Engineer, Lockheed Aircraft Corp.

Stimler, Frederick Jacob, B.S. in M.E.; Aero. Research Engineer, Daniel Guggenheim Airship Institute.

Sussman, William, A.B.; S.B.; Stress Analyst, Eastern Aircraft Div., General Motors Corp.

Transferred from Student to Technical Member

Amorim, Artur Soares, B.S.Ae.E.; Engineer, Brazilian Air Force.

Burk, Sanger Marsh, Jr., B.S.; Aero. Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Dickman, Paul Rowe, B.Ae.E.; Apprentice Engineer, Grumman Aircraft Engineering Corp.

Ellis, Sanford, B.Ae.E.; U.S. Army Air Forces.

Field, Robert Leslie, B.Ae.E.; Aero. Engineer, Navy Dept., Bureau of Aeronautics.

Fischer, Robert (Roberto de Jesús Fischer Saravia), B.S.Ae.E.; Apprentice Engineer, Pan American Airways System.

Graves, John "D", B.S. in Ae.E.

Henneberger, Adrian Leonard.

Johnson, Joseph Laurel, Jr., B.S. in Ae.E.; Aero. Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Kurbjun, Max Claus, B.Ae.E.

Kviljord, Arnold, B.Ae.E.; Flight Test Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Mac Carthy, Walter Thomas, B.Ae.E.; Aerodynamicist, Consolidated Vultee Aircraft Corp.

Myers, Philip Francis, B.S. in Ae.E.; Engineer Trainee, Lockheed Aircraft Corp.

Osofsky, Irving Bernard, B.S. in Ae.E.; Draftsman, Bell Aircraft Corp.

Peterson, Eugene Stuart, B.Ae.E.; Aerodynamics Group, Consolidated Vultee Aircraft Corp.

Schaettler, Frederic Jordan, A.B.; Engineering Aide; Air Transport Command, U.S. Army Air Forces.

Schuler, Llewellyn Carl, B.Ae.E.; Aero. Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Summers, Robert Allan, B.S. in Ae.E.; Jr. Aerodynamicist, The Glenn L. Martin Co.

Yang, Yih Chang, Jr., B.S. in Ae.E.

Elected to Affiliate Grade

Ellington, Ken, Secretary, Aircraft War Production Council, East Coast, Inc.

Ellis, Gordon Wilfred, Draughtsman, The De Havilland Aircraft of Canada, Ltd.

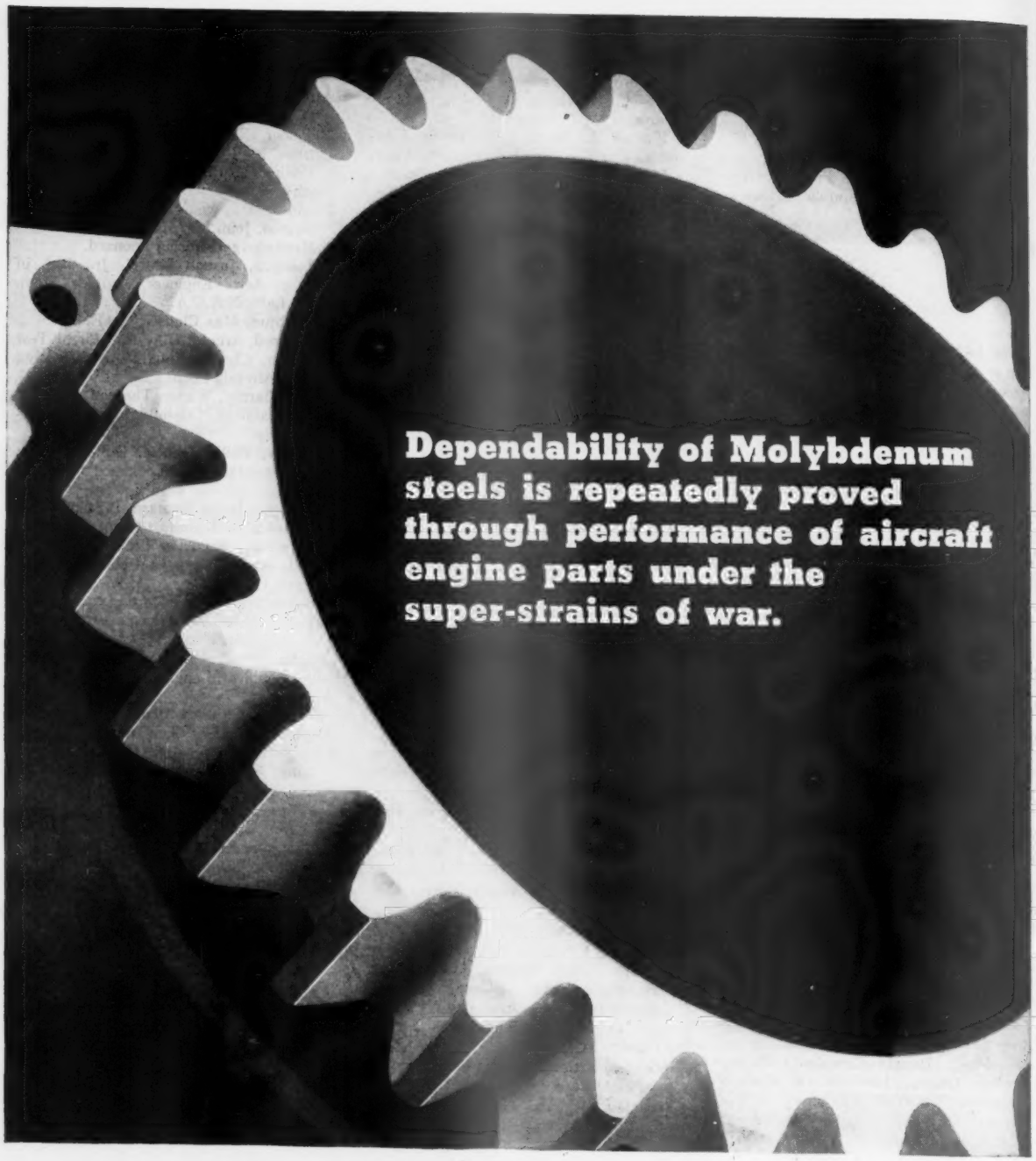
Personnel Opportunities

This column is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Detail & Layout Draftsmen, Stress Analysts, Design Engineer, Assistant Project Engineer on development work in the engineering department. Address inquiries to Edo Aircraft Corporation, 136-48 Roosevelt Avenue, Flushing, L.I., N.Y.

Graduate Engineer—Draftsman—Excellent immediate and postwar opportunity. Design airplane accessories. Aeronautical experience necessary. Particular reference to work in hydraulics and alighting gear. Engineering draftsman, with or without


Dependability of Molybdenum steels is repeatedly proved through performance of aircraft engine parts under the super-strains of war.

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MOLY

aeronautical background, also desired. Write direct, stating education, experience, age, and draft status to Mr. Robert D. Spencer, Manager, Aeronautical Sales & Engineering Department, The General Tire & Rubber Company, Akron, Ohio.

Aeronautical Engineer—graduate or equivalent in experience. Good working knowledge of airplane design, structure, materials, and stress analysis desirable. Background of naval aircraft specifications and manufacture considered excellent. Pleasing personality is essential. Apply or write to the Bureau of Aeronautics Representative, c/o Edo Aircraft Corporation, 13-10 111 Street, College Point, N.Y.

Stress Analysts—at least two years' experience on aircraft stress analysis for similar work on plastic aircraft assemblies involving nonwrinkling skin construction. Address inquiries giving education, experience in detail, draft status and salary requirements to Universal Moulded Products Corporation, Bristol, Va., Attention Dr. R. J. Nebesar.

Aircraft Engineers—Openings available in progressive Aircraft Company for layout and design engineers to cover Wing, Empennage, Power Plant, Fuselage, Electrical and Radio, Landing Gear, Hydraulics, Equipment, and Controls. Also openings for Tool Designers, Tool Planners, Production Planners, Loftsmen and Aircraft Drawing, and Template Checkers. Those presently employed in essential war work need not apply. Air mail complete detailed information regarding education, experience, salaries, former employers, age, family status, citizenship, and draft status, in order that we may be able to evaluate your qualifications from the first letter. Address inquiries Higgins Aircraft, Inc., P.O. Box 32, New Orleans 6, La.

Graduate Engineers for essential war work, opportunity for advancement and increased earnings. Aeronautical experience not necessary. Must be citizen, not employed in essential war industry, or have certificate of availability from the U.S. Employment Service Office or War Manpower Commission of your area. Write direct, stating school, age, degree, experience, draft classification, and marital status to Consolidated Vultee Aircraft Corporation, Industrial Training Division, San Diego, Calif.

Aero & Mechanical Engineers—Large engineering firm engaged in military work with growing backlog of postwar jobs needs engineering personnel in all categories: Designers, Layout & Detail Draftsmen, Stress Analysts, Checkers, etc. Location Manhattan. W.M.C. rules observed. Address inquiries to Box 263, Institute of the Aeronautical Sciences.

Chief Design Engineer—Graduate mechanical engineer, experienced on automotive radiators, with established AAF-1 high production manufacturer or automotive radiators. Worth-while salary. Sound peacetime future with resumption of automobile production. Write in complete detail. Enclose recent (nonreturnable) photo. Address inquiries to Box 252, Institute of the Aeronautical Sciences.

Industrial Engineers—Major coast-to-coast air line, strong background on accounting systems, operating cost accounting and capital items depreciation. Must be willing to leave city. Permanent position offering unlimited opportunity. Describe background in detail. Enclose photo. Address inquiries to Box 240, Institute of the Aeronautical Sciences.

AVAILABLE

Engineer-Test Pilot—M.S. in Physics, M.S. in Aeronautics. Two years' experience with aircraft manufacturer as test pilot and design engineer. Five years' experience air-line pilot; latter 2 years as air-line test pilot and Captain on transoceanic operations. Change contemplated because of termination of military contracts. Address inquiries to Box 264, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. in M.-E., M.S., 1½ years' experience in stress analysis of private airplanes, 6 years' experience in supervisory capacity with one major aircraft concern including 5 years of stress analysis and structural design of experimental and production Army and Naval aircraft and one year of static testing and structural research. Desires position in vicinity of New York City with consultant or with company having postwar plans for the development of personal airplane. Address inquiries to Box 262, Institute of the Aeronautical Sciences.

Engineer—Over 25 years' experience on airplanes, airships, aircraft accessories, mechanical devices, engineering investigations. Unusually broad and up-to-date knowledge of all metals, woods, glues, plastics, and finishes. Present executive position ends about November 1, due to curtailment of engineering. New York area preferred. Salary over $7,000. Address inquires to Box 261, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Graduate, 26 years old, 4½ years' experience in design and stress analysis of large all metal airplanes. Desires position in or near Minneapolis, Minnesota, $4,500 year. Address inquiries to Box 260, Institute of the Aeronautical Sciences.

Electrical Engineer—Graduate, age 30, family. Eight years' experience leading aircraft companies in design and research on electrical, radio and instrument components. Five years as a section head in the above capacities. Thoroughly familiar with related aircraft engineering problems. Desires responsible position having good postwar possibilities. Prefers vicinity of Los Angeles, South America, or other suitable location will be considered. Address inquiries to Box 259, Institute of the Aeronautical Sciences.

Structural Aeronautical Engineer—Extensive experience in military and commercial aircraft development, and as design project engineer, desires responsible engineering position in air cargo development, or other postwar project in eastern or northeastern area. Release available, draft exempt. Address inquires to Box 258, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Varied design experience. Thoroughly familiar with light-plane field. Private pilot. For past two years have done development and sales engineering for aircraft accessories firm. Desire responsible position, West Coast. Address inquiries to Box 257, Institute of the Aeronautical Sciences.

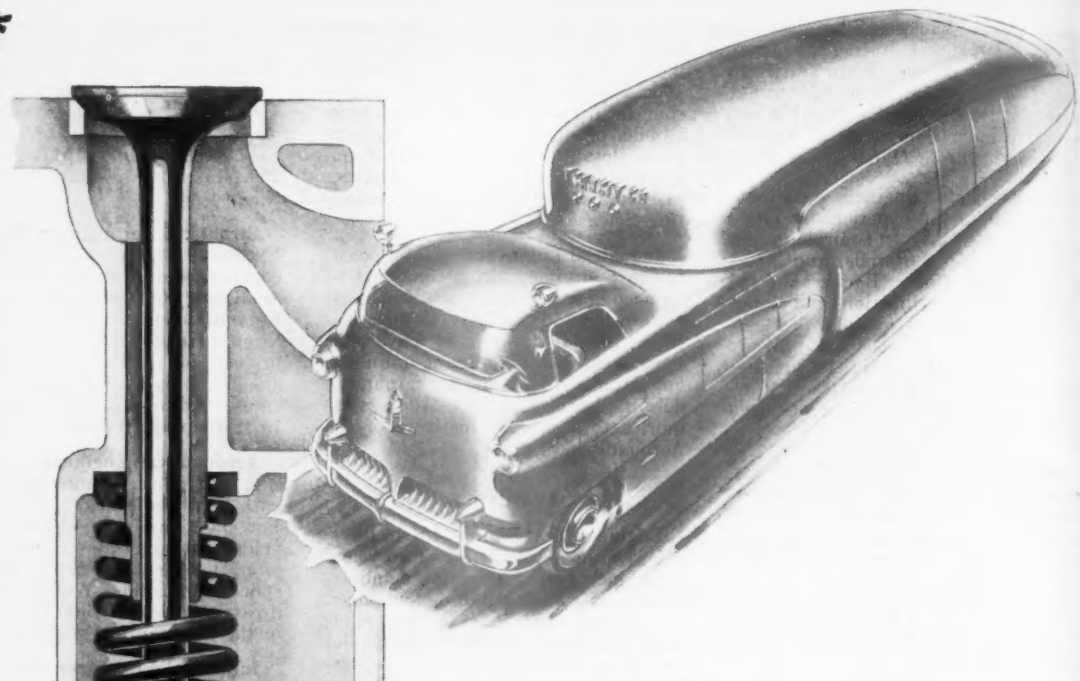
Industrial Engineer—Broad and varied experience in Plant Layout, Tool Design, Tool Control, Methods, Procedures, Hours Control, Work Simplification, Cost Analyzation, Incentives and Reports. Wants responsible position; can go anywhere; now employed; can comply with W.M.C. Regulations. Address inquiries to Box 256, Institute of the Aeronautical Sciences.

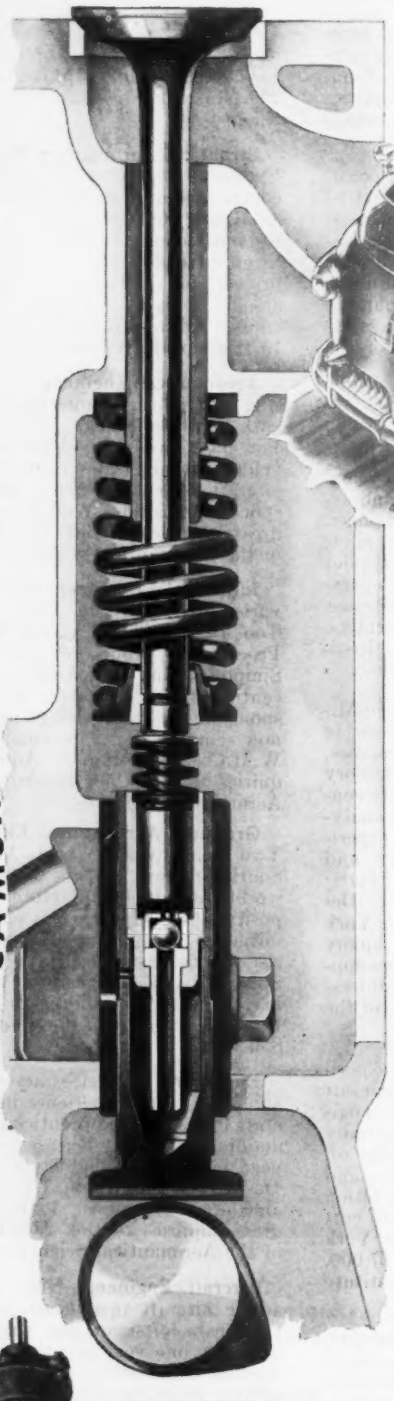
Graduate Aeronautical Engineer—Two years with World Airline in South America, 3 years with a senior world aircraft manufacturer, desires position requiring tactful exercise of initiative and resourcefulness as assistant export sales executive; speaks Spanish and Portuguese fluently; travel anywhere. Address inquiries to Box 255, Institute of the Aeronautical Sciences.

Engineer—Graduate, aeronautical, age 29, 4 years' experience in the aircraft industry as apprentice.engineer, detail draftsman, field service engineer, power-plant flight-test engineer. Desires work in Middle West. Available after November 1, 1944. Address inquiries to Box 254, Institute of the Aeronautical Sciences.

Aircraft Engineer—Nine years in active aircraft operations, including two years loftsman, one year liaison engineer, one year supervisor of production engineering, two years engineering representative for all subcontracted parts of large West Coast manufacturer, one year research and development engineer for Rocky Mountain firm. All W.M.C. affidavits approved. Desires position of engineering trouble-shooting or representation, preferably foreign and tropical. Will also consider any reasonable Southern California offer. Address inquiries to Box 253, Institute of the Aeronautical Sciences.

FROM CAMSHAFT TO COMBUSTION CHAMBER





IN ADDITION TO the Eaton Rotor Pump (shown at left) the Wilcox-Rich Division of Eaton Manufacturing Company produces parts for the complete valve assembly—including Zero-Lash Hydraulic Valve Mechanisms, Mechanical Tappets, Self-Locking Screws, Valve Springs, Valve Seat Inserts, and Automotive and Aircraft Valves.

For efficient valve operation, the correct design of every unit of the valve train is just as important as the design of the valve itself. That is why Wilcox-Rich engineers, who are specialists in dealing with valve problems, do constant research on *all* units which in any way affect the efficient operation of the valve mechanism. In 33 years Wilcox-Rich has made countless contributions to the development of internal combustion engines—from camshaft to combustion chamber—including pioneer production of the hydraulic tappet and the sodium cooled valve. Now that postwar plans are in the drawing board stage, the complete engineering facilities of "Valve Headquarters" are available to aid in the design and improvement of valve mechanisms for automotive, aircraft, and stationary engines.

EATON

MANUFACTURING COMPANY

WILCOX-RICH DIVISION

9771 FRENCH ROAD • DETROIT 14, MICHIGAN

Aeronautical Engineer—B.S. and M.S. degrees. Nine years' experience in structures, wind-tunnel testing, weights, and flight testing. Have been chief of structures for three well-known manufacturers. Desire commensurate position with company having postwar possibilities. Address inquiries to Box 251, Institute of the Aeronautical Sciences.

Aeronautical Development Engineer—College graduate with six years' experience in design and development of commercial and military airplanes desires responsible position in small concern in executive or development capacity. Capable of taking complete charge of new projects. Present position, project engineer. Would consider air-line work. Address inquiries to Box 250, Institute of the Aeronautical Sciences.

Engineering Representative, ten years' aircraft experience in supervision of departments and direction of projects, widely traveled, graduate Aero and Mechanical engineer and business training; desires permanent connection where engineering and business background can be utilized in sales or production; married, will travel. Address inquiries to Box 249, Institute of the Aeronautical Sciences.

Graduate Aeronautical Engineer—17 years of practical experience in military and commercial aircraft development, design, and supervision. Acted as consultant, project engineer, and designer in responsible charge of engineering work and personnel with major aircraft companies. Desires responsible and permanent position with aircraft company. Willing to accept position in South America or other suitable foreign country. Address inquiries to Box 245, Institute of the Aeronautical Sciences.

Mechanical-Aeronautical Engineer—5 years, major aircraft stress analysis. Desires connection with west coast airframe or accessories company. Address inquiries to Box 244, Institute of the Aeronautical Sciences.

Layout Draftsman—21 years old, 2 years' experience in large aircraft factory in power plant and wing design; 2 years' experience tool and machine designing; recently honorably discharged from Army. Desire position with postwar future in large aircraft company, preferably in vicinity of New York. Address inquiries to Box 243, Institute of the Aeronautical Sciences.

Inspector and Production Engineer—5 years' experience in high-altitude fighter planes, desires employment with transport air line having postwar future. B.S. degree; linguist; any location. Address inquiries to Box 237, Institute of the Aeronautical Sciences.

Graduate Engineer—Five years' experience, varied, in production control, planning, cost estimating and control, tooling, engineering, weights, and aerodynamics. Permanently draft deferred, single, release available, present salary $7,000 per year. Considerable experience in writing and preparation of technical reports, specifications, and proposals. Experienced in helicopter engineering and aerodynamics. Wants responsible position, permanent, in production or engineering with reputable firm, preferably in East but will travel if necessary. Address inquiries to Box 236, Institute of the Aeronautical Sciences.

Director of Quality, Chief Inspector for aircraft construction contact with Army or Navy (Navy preferred), 20 years' aircraft experience, also interested in aircraft maintenance, overhaul and repair. Address inquiries Box 230, Institute of the Aeronautical Sciences.

Consultant Aeronautical Engineer recently discharged Army Air Forces, formerly executive Chief Engineer, desires additional consultant work under contract. Address inquiries to Box 205, Institute of the Aeronautical Sciences.

(*Continued from page 151*)

faster and cheaper; (14) special radio wrench constructed of micarta aids in working around hot wires; (15) reworking head of one-shot dimpling riveter when application is correlated to dimpling yoke solves problem of alignment and saves tool breakage; (16) use of Tinnerman clips, instead of angle clips for litter-bag installation, eliminates drilling operation.

The Consolidated Vultee Volunteer, September 29, 1944. (1) Use of a stainless-steel sleeve on pistons, instead of one made of fiber, prevents sticking of the sleeve to the magnetic rivet gun; (2) a jig for locating attach angles.

Fairchild Fad, September 8, 1944. (1) A coil winder for repairing burned-out motors reduces time and expense of motor repair; (2) a safety arrangement for Tannewitz saws eliminates danger of injury to operator's fingers.

The Grumman Plane News, September 14, 1944. (1) A special tool for installing stop nuts in radar-nacelle assembly; (2) a special wrench for removing rear caps from gun-charger panels; (3) new method for installing hydraulic relief valves on landing gears; (4) new method for using hold-down clamps for manifold jig work; (5) a cutting tool for trimming skins on the intermediate section of the plane; (6) the use of hinged plates on rubber press dies for small flanges; (7) a production screw driver used for clevis bolts on center-section beams; (8) a gear and ring puller for olio-strut repair.

North American Aviation, Inc., Take-Off, October 6, 1944. A floating die head adapter permits free movement of the threading tool held in the chuck of an engine lathe.

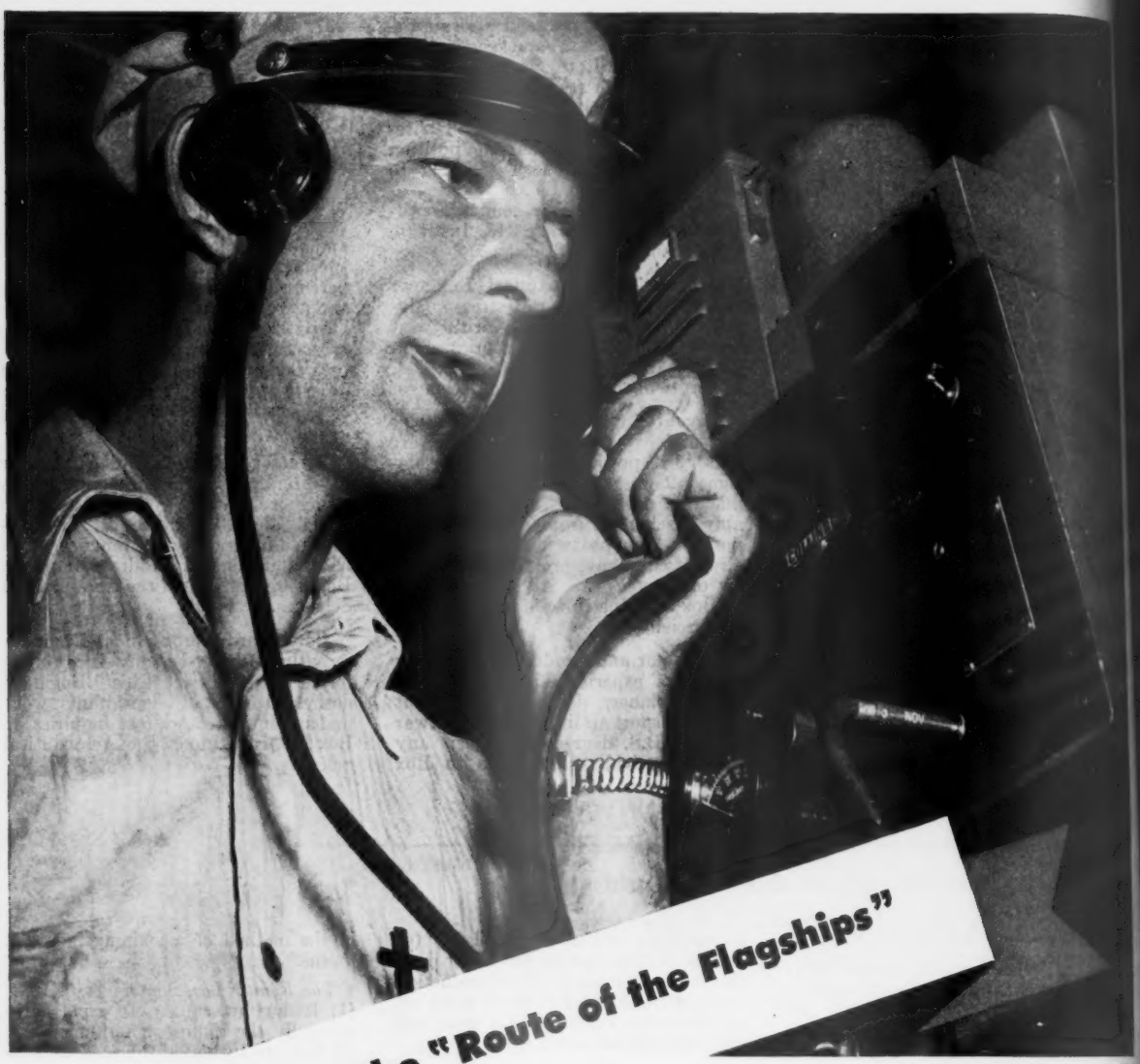
North Ameri-Kansan, October 6, 1944. An improved flycutter for a vertical milling machine enables milling and slotting operations to be performed simultaneously and results in a deep cut, a smoother finish, and increased speed.

The Curtiss Wright-er, September 29, 1944. (1) Revision of the 70 per cent spar jig permits drilling while spar is in either vertical or horizontal position; (2) templates for drilling rivet patterns in lower tail skins; (3) a rapid adjustment device for the Chicago Automatic Riveter; (4) tools for locating stringer clips; (5) the substitution of spot welding for gas welding on the antenna-duct assembly; (6) combination holder for cleco buttons and skins results in a saving of steel, reduces rework time, and enables the same die to be used on several jobs; (7) a change in the method of machining fuel-tank drains.

The Kinner Log, September 5, 1944. (1) Radius attachment to grind automatically the radius on forming tools; (2) balance turntable to speed up production on finish grinder assemblies; (3) air vent for dynamometers; (4) method that eliminates holding the hob with the fingers during the process of grinding; (5) a fixture for holding used cylinder assemblies; (6) collet fixture that decreases set up time in tool room cylindrical grinding.

The Jahco News, September, 1944. (1) A new type anvil used in Rockwell-testing of parts increases production and eliminates possibility of obtaining a wrong reading; (2) lapping gears with oil on the Norton Lapper to get them flat eliminates a slow operation on the milling machine, improves the quality of the gears, and increases production; (3) instantaneous-overload relay switches for the spindles of the Goss Automatic Machines afford warnings to the operators when tools become dull and permit units to be set for various loads, thus reducing loss of production caused by tool or machine breakage.

Simmonds Aeronews, September 29, 1944. New method of Magnafluxing parts for automatic engine controls.



Standard on the "Route of the Flagships"

ARMY E NAVY

IN 1939, American Airlines adopted the Collins 17F Autotune* aircraft transmitter as standard equipment for its entire fleet.

Previous experience on a lesser scale had indicated the wisdom of this step. Succeeding experience has confirmed it.

Compared with previous equipment, the 17F's doubled the power output (to 100 watts) with slight increase in weight, and the Autotune* provided thirteen quickly available operating frequencies instead of three.

Daily through the years, these rugged, uniquely efficient airborne 17F's and powerful Collins ground transmitters have given trustworthy support to a superb Operating Department in maintaining the great American Airlines tradition of safety and dependability.

After the war, Collins will again specialize in the development and production of advanced types of communication equipment for commercial aviation.

Its designs will bear the fruit of intense research and outstanding engineering achievement now engaged in meeting the hard demands of military service all over the world. Collins Radio Company, Cedar Rapids, Ia.

*The Collins Autotune is a repositioning mechanism which quick-shifts all transmitter or receiver controls simultaneously and with extreme precision to any one of a number of pre-determined frequencies. U. S. Patents issued and pending.

COLLINS